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CUSTOM BUILD TRANSFORMS
GOOGLE'S MOBILE PLATFORM
INTO A REAL DESKTOP OS!

android

May 2016
Issue 428

YOUR EXPERT

GUIDE



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vs SURFACE**

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DIY MEDIA CENTRE PC

In-depth PC
builder's guide:
What you need to
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Going cashless: a double-edge sword

FINANCIAL TECH IS SHAKING UP THE BANKING
SECTOR, BUT WILL CONSUMERS BE LEFT
POORER FOR IT?

If you're someone who likes to use a VPN or 'smart DNS' service to let you browse overseas content on streaming sites like Netflix, you'll likely have been watching the news of the latter's cracking down on 'geododgers' with baited breath. So far, Netflix seems to be targeting the services that specifically flaunt the fact that they can get around streaming geoblocks, rather than the bigger privacy-focused VPNs – the one I'm personally subscribed to (the discretely named Private Internet Access) seems to be working fine.

What's perhaps a bit more worrying is that fact that PayPal has recently started blocking payments to VPN services. That's ostensibly because they can be used to hide your identity if you're pirating content, and it's likely a move that's been made under pressure from the same Hollywood industry groups and the need to keep business partners happy that's brought about the Netflix crackdown.

From our perspective, though, using a VPN is a bit like rooting your Android or jailbreaking your iOS device: the manufacturers may not like it, but it's by no means illegal. (And indeed, even our own Prime Minister Malcolm Turnbull uses a private encrypted messaging

service.) There are perfectly legitimate and legal reasons for using a VPN, including avoiding our government's 'driftnet' style collection of your metadata or protecting yourself from hackers while you're using a public Wi-Fi hotspot. In fact, we'd say that, for travellers relying on free Wi-Fi to stay connected, the latter use makes having a VPN subscription a must-have. For users in China and other countries with highly restricted internet, VPNs give access to information outside that carefully walled garden.

And it has worrying, broader implications for the cashless direction our society is headed in. Being able to pay for everything with just your phone or a quick tap of your bank card is all well and good, but when the financial companies holding the reins on those transactions start dictating which vendors you can and can't buy from, we should all start to be wary. Now if you'll excuse me, I'm off to find an ATM. ■



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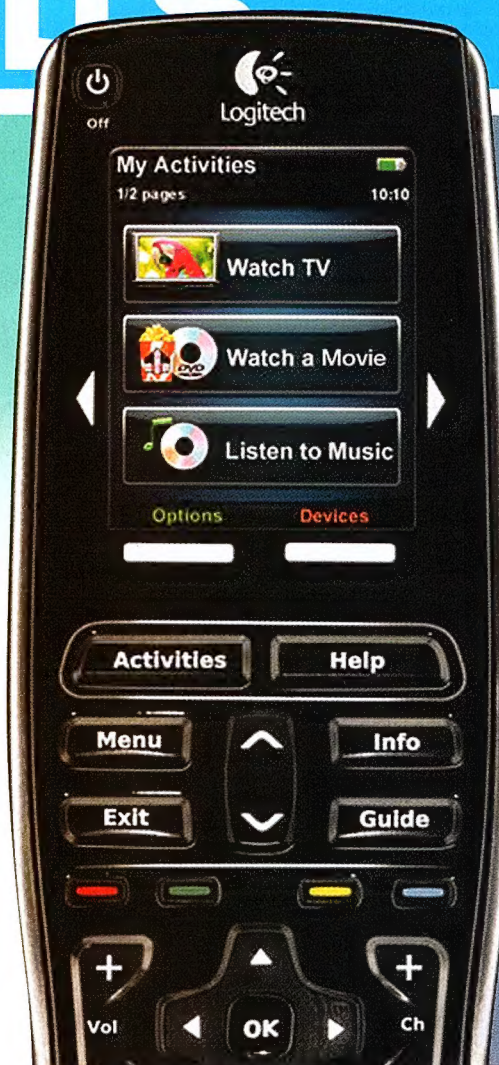
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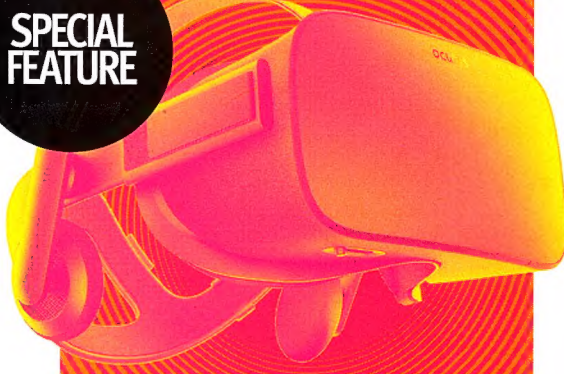
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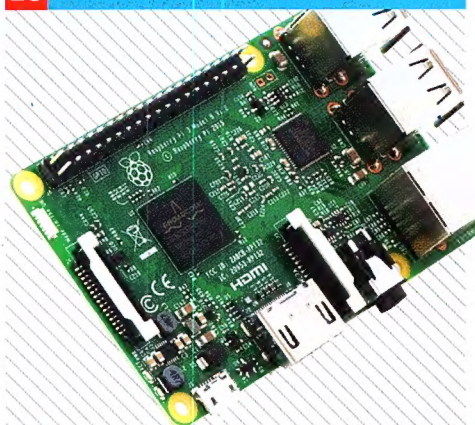
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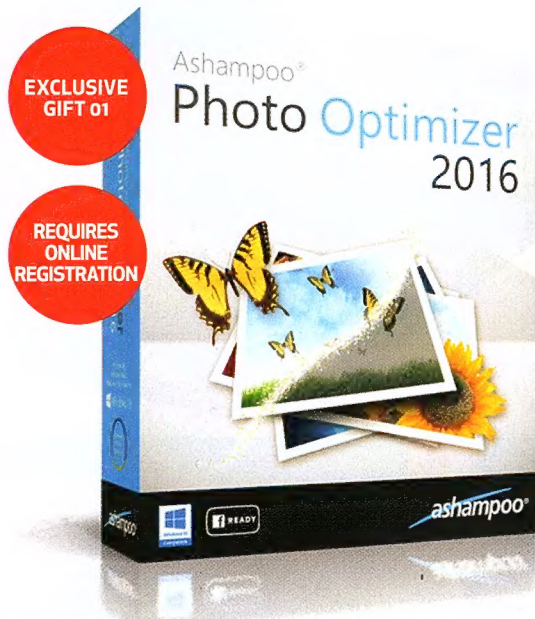


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DOWNLOAD LINK: www.ashampoo.com/lpa/apc



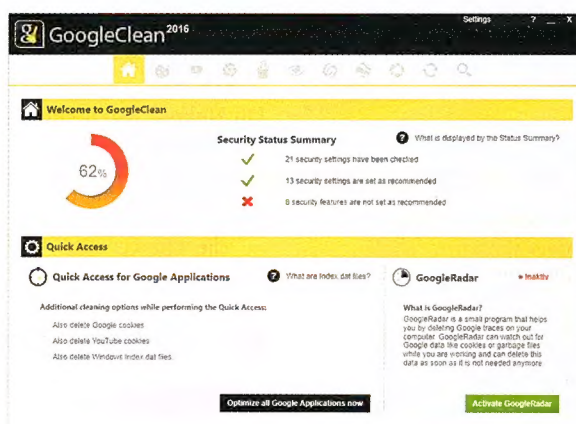
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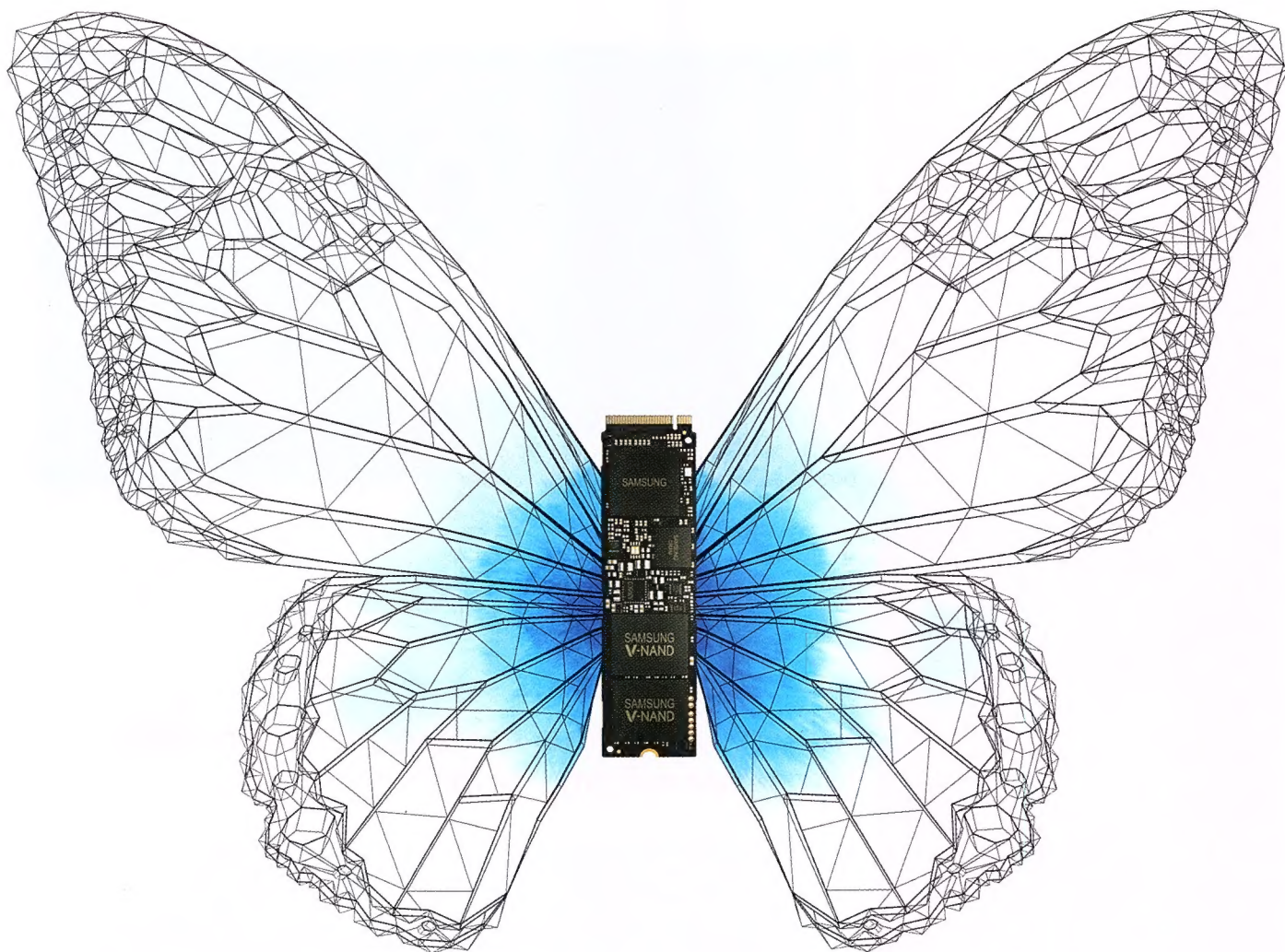
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Valve loses local legal battle over refunds

ACCC lets off no steam.

Australia has strict consumer laws regarding refunds, and Valve – the operators of game- and software-distribution platform Steam – has learned the hard way. Although Steam implemented a global, no-questions-asked refund service last year, it didn't exist back in 2014, when the proceedings were initiated by the Australian Competition and Consumer Commission (ACCC). The court arrived at its verdict last month, deciding that Valve's old refusal to refund goods was in violation of Australian consumer law. The company could be fined up to \$1.8 million. **SP**

Linux apps could soon run on Windows 10

Ubuntu for Microsoft's OS due in winter?

Thanks to a partnership between the Redmond company and Canonical, the organisation responsible for the Ubuntu version of Linux, you'll soon be able to design and run penguin-themed programs on Windows 10. Called Windows Subsystem for Linux, this new tech will allow developers to manage their projects using the same commands as they would on Linux, without the need to run a resource-intensive virtual machine. **PT**

Windows 10 is go

Whether you like it or not.

Windows 7 and 8.1 users are reporting that their machines have installed Windows 10 without their permission. A Reddit thread with nearly 3,000 comments details users accounts of their machines installing the new O/S while they were away from their machine. A post from a representative at Microsoft shrugs its shoulders at the reports, stating that users and users alone are in control of updates. **PT**

Piracy battles

Publishers aim to block major torrent sites.

Foxtel and Village Roadshow have gone to the courts to block Aussies from accessing prolific torrent sites. The two companies are attempting to place a block on IsoHunt, The Pirate Bay, SolarMovie, Torrentz and TorrentHound at the domain level. To do so, they must provide proof that the sites are being used primarily for facilitating the distribution of pirated material. **PT**



Facebook, Google and Snapchat to beef up security

Despite US government demands, major tech companies will employ more encryption.

Some of the world's largest tech companies, including Google, Facebook and Snapchat have been spurred on by Apple's recent fight with the FBI – regarding the iPhone at the centre of the San Bernardino shooting investigation – to enhance their own products' security. So far, these companies (in addition to Amazon, Microsoft and Twitter) have supported Apple's position in the now-dropped case, but this suggests that those written statements of support will become more substantial. WhatsApp has been heightening its security incrementally since 2014, but the Facebook-owned app recently turned on encryption for all voice calls and group messages. And it's not alone. Snapchat is also working on a secure messaging system, Google is working on encrypted email... even Twitter is exploring the prospect of encrypted messaging again. While these projects began before the San Bernardino case, there is a renewed sense of urgency within the tech industry, the fruits of which will undoubtedly ruffle a few feathers in Washington. Society as a whole still seems split on the ethics of privacy and the need for technology "backdoors". **Carmel Sealey**

FBI gains access to iPhones without Apple's help

After 'the case that almost was'.

The conflict between the US Justice Department and Apple over backdoor access to the iPhone is over — but not in the way you might have expected. Rather than either party giving in, the Justice Department has found an alternative method to gain access to the heavily encrypted firmware and operating system — one that doesn't require Apple's help at all.

"Our decision to conclude the litigation was based solely on the fact that, with the recent assistance of a third party, we are now able to unlock that iPhone without compromising any information on the phone," United States Attorney Eileen M Decker said. "Although this step in the investigation is now complete, we will continue to explore every lead, and seek any appropriate legal process, to ensure our investigation collects all of the evidence related to this terrorist attack."

The Justice Department had sought Apple's help in accessing an iPhone owned by one of the perpetrators' of the 2015 San Bernardino shootings. Apple has staunchly refused, stating that providing the technology to do so would undermine the security of all its iOS devices. **Shaun Prescott**

Console vs PC online gaming could soon be a reality

Xbox, PS and PC players to face off thanks to Microsoft effort?

Last year, Xbox head Phil Spencer was asked why Square Enix's *Final Fantasy* MMO hadn't made it to Xbox One. His answer blamed a possible exclusivity deal between Sony and Square Enix. He was wrong. The real answer, as *Final Fantasy 14*'s game director Naoki Yoshida explained months before, was that Microsoft's cross-platform policy wouldn't allow it. There are several titles on PS4 that allow multiplayer gaming with PC users, but none for Xbox One.

That could change, though, with Microsoft's announcement that it will support cross-platform play. That's easy enough to achieve with the PC install base, but to do so with Sony might still be a pipe dream. Speaking to Eurogamer, Sony gaming head Shuhei Yoshida indicated that it would be unlikely. "Because PC is an open platform, it's much more straightforward," he said. "Connecting two different closed networks is much more complicated, so we have to work with developers and publishers to understand what it is they are trying to accomplish."

"We also have to look at the technical aspect — and the technical aspect could be the easiest. We also have to look at policy issues and business issues as well." SP

Anonymous declares "total war" on Donald Trump

Hacktivists take aim at the presidential candidate.

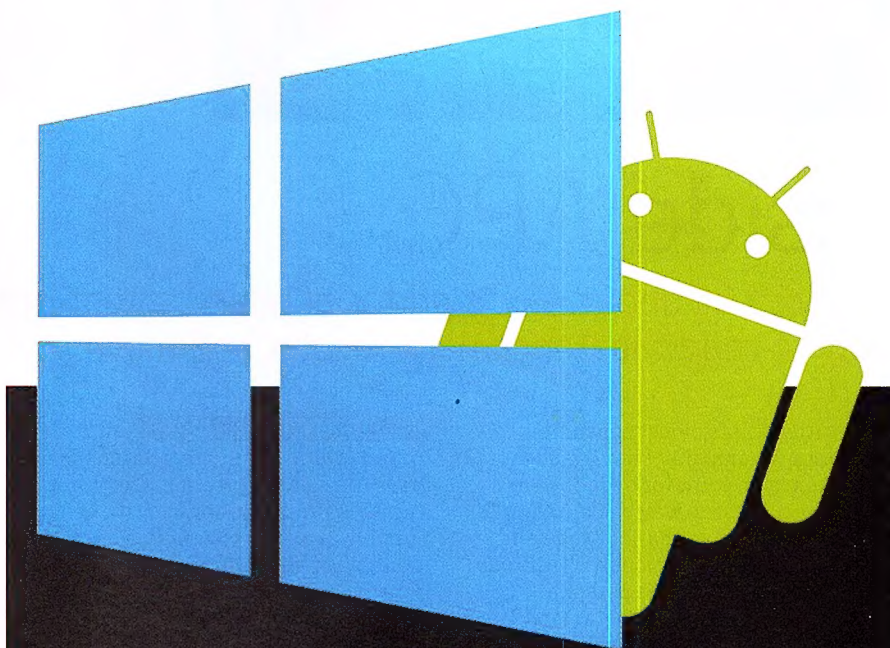
In a video posted in March, the group expressed its hopes of sabotaging his campaign but also "his brand", by exposing information about himself and his staff, and shutting down his numerous websites. According to the masked representative for Anonymous, they are targeting the Republican due to his "hateful campaign" and "appalling actions and ideas". At time of writing, no such dramatic action appears to have taken place. CS



Intel abandons 'tick-tock' chip-development strategy

Adds third step to allow for more refinement.

Chip manufacturer Intel is altering its decades-old manufacturing schedule from a two-stage to a three-stage process, giving itself more time for generational leaps in technology. Previously known as 'tick-tock' — the 'tick' (process) being a new CPU that would shrink the preceding processor to a smaller size, and the 'tock' (architecture) introducing, surprisingly, a different architecture that incorporates new features and more efficiency — Intel's new development model adds a third step: optimisation. This means that Intel's 14-nanometer manufacturing process will stick around longer than the company's previous stages, and the same applies for upcoming 10-nanometer chips. It's a development change that's been slowly happening over the last couple of years. Haswell was a soft 'tock', for example, while Devil's Canyon was also a refresh rather than a generational leap. Kaby Lake, due out later this year, succeeds Skylake. Meanwhile, the next-generation 10-nanometer Cannonlake will be available in 2017, to be refreshed by Ice Lake in 2018, and again by Tiger Lake in 2019. Paul Taylor



Microsoft builds then burns Android bridges

Porting solutions nixed.

Microsoft wanted to make it easy for mobile app developers to port their software over to Windows 10, without having to rewrite their code, so it created a series of so-called bridges. They're essentially toolkits designed to do the dirty work for developers. There was one for porting Android apps to Windows 10, called Project Astoria, but it's now appropriate to refer to it in the past tense because Microsoft has burned that bridge.

The other bridges Microsoft has built include one for porting iOS apps over to Windows 10, and another for web apps. There are also plans to build a bridge for Win32 apps sometime this year. Those are unaffected by the announcement, though the iOS bridge may see an uptick in activity.

News of the change comes a day after Microsoft inked an agreement to acquire Xamarin, a cross-platform mobile development software vendor. PL

technotes

» INSIDE APC



Inside APC

Find out all about APC's editorial policies, test practices, how to read the benchmark results and more.

APC is Australia's oldest consumer technology magazine – having been consistently in print for over 35 years, since our first issue way back in May 1980 – and we take that heritage and responsibility very seriously. While our focus is obviously on the personal computer – it's in our name, after all – the very definition of the PC has changed and shifted markedly since the early 1980s. As such, we touch on many other areas of tech too, from smartphones and apps to peripherals, accessories, online services and beyond. We have two main goals: to track down the best of modern tech and also to help our readers make the most of it.

We're also an open church in terms of platforms. We know most people aren't wed to a single brand's products and use a variety of devices. And like you, APC's journalists want to know what's good in tech – no matter what platform it resides on.

INDEPENDENT REVIEWS

Championing technology doesn't mean we're unrelenting yes-men, however, and APC aims to be as objective as possible in all our coverage. That means identifying the best products from multiple perspectives – the best performance, best value and best features and, ideally, the products that offer the best mix of these three.

As a matter of policy, reviews published in APC are not shared with product-makers prior to print. We will contact vendors under certain conditions; for example, if we have a problem testing a product that seems to indicate it may be faulty, or to invite a vendor to clarify how a particular feature works. If an APC reviewer has any potential conflicts of interest involving a brand, the review will always be assigned to another writer.

LABS TESTING

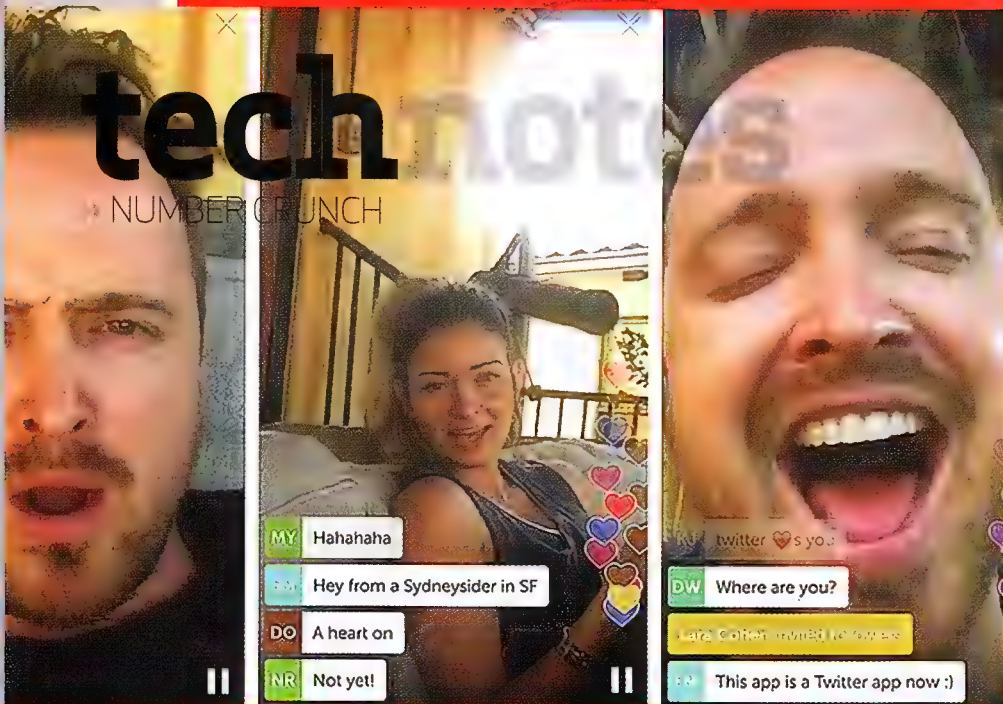
Despite being a small magazine with limited resources, APC still strives to conduct the most rigorous, objective scientific tests and benchmarks we can so as to make our reviews as unbiased as possible. We use a variety of tools and programs for this, including many freely available benchmark suites for assessing media encoding, general system performance, gaming and battery life.

In most cases, for the benchmark results published in APC, you can assume that higher is better. There are certain tests that deviate from this rule and where the opposite is true; in those cases, we've flagged the results with a note explaining as such.

We use both tables and graphs for displaying results; the latter are our preference due to their ease-of-readability, but tables are more compact, so we use these in cases where thoroughness is preferred.

technotis

NUMBER CRUNCH



200MILLION

THE NUMBER OF LIVE STREAMS THAT HAVE BEEN BROADCAST ON TWITTER'S PERISCOPE.

At the end of March, video-streaming app Periscope — which allows anyone to use their phone to broadcast live video to their Twitter followers — celebrated its first birthday with over 200 million worldwide streams under its belt. Even more surprising than that total is that 100 million of those streams were watched in the first three months of 2016, with the company reporting that users now collectively watch over 110 years of footage every day.

0.19 PERCENT

THE MINISCULE FRACTION OF MOBILE GAME PLAYERS THAT ACTUALLY SPEND MONEY ON THEM.

The Interactive Games and Entertainment Association reports that smartphone gaming is the 'largest segment of the digital games ecosystem', responsible for a respectable portion of Australia's \$3 billion annual gaming revenue. But unlike other games platforms, only a tiny portion of mobile game players are actually footing the bill. According to the marketing research firm Swrve and its data on over 40 free-to-play mobile games and over 20 million players, if you were to split the total revenue of the mobile gaming industry right down the middle, 50% of sales come from an estimated 0.19% of the total mobile gamers.

314 gigabytes

THE CAPACITY OF WESTERN DIGITAL'S NEW SPECIALLY DESIGNED RASPBERRY PI HARD DRIVE, A HOMAGE TO THE NUMBER PI.

Shaving 6GB off the usual 320GB hard disk drive capacity, the makers of the Raspberry Pi have commissioned Western Digital to create a bespoke 314GB drive — a reference to the infinitely-long (probably) and highly-useful number Pi, AKA 3.14. Usually costing US\$45, the modified external drive has reduced power consumption specifically designed for the micro PC and was initially sold for US\$30 (around AU\$40). With an included version of Berry Boot, the drive will even store multiple OSs on the drive and easily flick between them.

100K

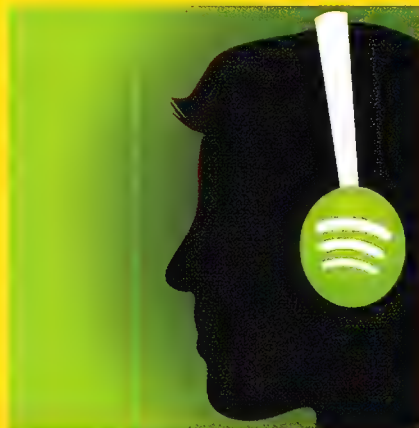
THE NUMBER OF RECALLED TOSHIBA LAPTOPS AFTER BATTERIES MELT.

Toshiba has had to issue an embarrassing recall of nearly 40 different laptop models that were purchased in the US and Canada between 2011 and 2016, after a number of their Panasonic-made batteries overheated and melted. The United States Consumer Product Safety commission estimates that the recall will affect 91,000 devices in the US and another 10,000 in Canada. The laptops are eligible to be replaced by Toshiba at no cost. It's unclear how many Australian devices contain the faulty batteries but you can check your battery through Toshiba's website (batterycheck.toshiba.com).

30 million

THE SUBSCRIBER BASE OF SPOTIFY.

Spotify has only publicly released its subscriber numbers once since it announced it had 20 million users in the lead up to the launch of Apple Music in July last year. The music-streaming service has grown an extra 50% since then — seemingly unphased by the arrival of Apple's juggernaut. Spotify may have even benefited slightly with the arrival of Apple and Tidal, legitimising the music streaming space and raising all boats.



technotes

» GEAR WE WANT

INTEL SKULL CANYON GAMING NUC

THE MINI PC WITH A LITTLE MORE GRUNT.

US\$650 | WWW.INTEL.COM

In March, Intel announced that it would be launching its next 'Next Unit of Computing' (NUC) – which, apart from having the best spec sheet we've seen in a NUC, flaunts a low-profile glossy plastic shell, occupies twice the surface area of a regular NUC and has a giant embossed skull plastered on the top of the case. The new Skull Canyon NUC is built around one of Intel's Core i7-6770HQ SoC processors, running between 2.6GHz and 3.5GHz and paired with an integrated Iris Pro Graphics 580 GPU. Not a bad price considering you'll be able to game in 900p and that the i7-6770HQ CPU goes for US\$450 on its own.



ACER PREDATOR Z850 GAMING PROJECTOR

WHO SAID SIZE DOESN'T MATTER?

US\$4,999 | WWW.ACER.COM

PC monitor manufacturers have, of late, been doing a lot of work to make sure gaming screens display games at their best, but even the biggest LCDs still can't compare with a projector for picture size. Projectors have other problems when it comes to showing games but Acer's new Predator Z850 apparently hopes to deal with at least some of those. It's unconventional in other ways, too, with a 24:9 aspect ratio and 1,920 x 720-pixel resolution, plus the ability to project a 120-inch image from as close as 47cm from the screen. It uses a DLP projection system and a laser diode lamp to deliver a 10,000:1 contrast ratio and a 3,000-lumen brightness. We're very keen to give it a whirl, but there's no word yet on an Aussie release.

SEAGATE INNOV8

ONE (USB) CABLE TO RULE THEM ALL.

US\$349 | WWW.SEAGATE.COM

USB 3.1 and its new Type-C connector have some pretty amazing data transfer benefits, but they're also capable of delivering close to 50 times the wattage of USB 2.0 and around 25 times more power than USB 3.0. Seagate is the first drive maker looking to put that increased power delivery to work, recently revealing the world's first 8TB desktop hard drive that transfers data and is solely powered by a single USB Type-C port. You'll obviously need a reasonably new computer with both USB 3.1 and a Type-C port to make use of this one, but at least the Innov8's sleek modern design won't look out of place sitting next to your other cutting-edge tech.





SAMSUNG FAMILY HUB REFRIGERATOR

BRINGING YOUR FRIDGE INTO THE DIGITAL AGE.

APPROXIMATELY \$6,800 | SAMSUNG.COM

Your current fridge probably has an assortment of notes and reminders stuck on its door, along with pictures drawn by your kids and a selection of animal-shaped magnets. To replace all those bits of paper, this super-fridge has a 21.5-inch HD screen built into one door, and Wi-Fi connectivity that allows it to connect to your home network and become part of the great Internet of Things. You can use the screen to view calendars and notes, display recipes or photos, and you can even watch TV or stream music to the fridge, courtesy of its built-in set of 4W speakers. And if you're having people over for a party, it can stream music all through your home to external Bluetooth speakers.

The gonzo high-tech ideas don't stop there, either. Three cameras inside the fridge take snapshots each time you close the fridge door, and you can use the companion apps for iOS and Android phones to check the fridge's contents to see if you need to pick up milk or something else on the way home from work. Samsung is even working on a scheme with MasterCard that will allow you to order your groceries from that app so that you don't need to bother with anything as tedious as visiting a store yourself. Believe it or not, there's a smart oven in the works, too.

CUBETTO

CONTROLLING A CUBE WITH CODE.

US\$225 | PRIMOTOYS.COM

This is a really great way to teach logic and coding to kids. Cubetto is a little smiley cube with wheels, and it can be 'driven' by placing blocks into a wooden board along a 'queue'. Green blocks move Cubetto forward, others turn it, and so on — they execute in the order they're placed in the queue. It comes with a play mat, on which kids can send Cubetto out on adventures. It's built for Montessori-style learning, and is aimed at ages three and up. Our only disappointment is the price: Primo Toys believes coding is a "basic literacy" for kids, yet \$225 is a pretty steep barrier to entry.



OSSIC X

REVOLUTIONARY CARRY-ON LUGGAGE.

US\$399 | OSSIC.COM

The rise of more advanced personal entertainment demands a better class of headphones. The Ossic X aims to bring accurate 3D sound to all, by calibrating its audio to the shape of your head and ear, ensuring that its multiple drivers can replicate surround sound properly. This means you can use it for a truly epic movie experience at home in front of your TV, on the move with an iPhone or iPad, or for a more immersive gaming experience at your Mac. It can connect over USB or 3.5mm jack, and will pair brilliantly with virtual reality applications too. All that fancy calibration tech doesn't come cheap, though. ■

technotes

HOW IT'S DONE

Microsoft Surface Pro 4

Microsoft's best tablet yet, but it's a pain to fix.

BACKGROUND:

Anyone else sick of apples? Time to take a bite out of a juicy Microsoft offering, the Surface Pro 4, to see what it's made of. We're hoping Microsoft has opted for a more fixable laplet (laptop+tablet, eh?) this time. There's only one way to find out... OK, two ways — we have X-ray vision. It's teardown time!

MAJOR TECH SPECS:

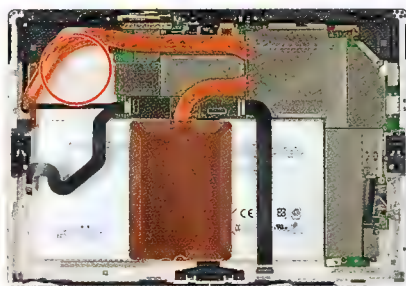
- 12.3-inch PixelSense 2,736 x 1,824 (267ppi) IPS LCD display
- Intel Skylake Core m3 (4M Cache, 2.2GHz) up to Core i7 (8M Cache, 3.8GHz)
- 4GB/8GB/16GB DDR3L 1,600MHz RAM
- 128GB/256GB/512GB/1TB of PCIe solid state storage
- 8MP rear-facing 1080p camera, 5MP front-facing camera
- USB 3.0 port, microSD slot, mini DisplayPort, and SurfaceConnect charging port
- 802.11a/b/g/n/ac dual-band Wi-Fi and Bluetooth 4.0

KEY FINDINGS:

- Sticky nightmares haunt our engineers after the harrowing Surface Pro 3 teardown, so we've prepared for the worst. Things start to heat up as the iOpener battles to

weaken the display's adhesive. As soon as we get an opening pick under the edge of the display, we're off! We strain our ears to listen for the telltale cracking of glass, but it seems as though we're getting away with this opening procedure shard-free!

- The last time we tore down a Surface Pro, we encountered a display connector trapped beneath a springy metal bracket. This time, there are two cables holding the display to the body. Our only recourse: tackle those connectors. And, of course, Microsoft has modified its connector design. The display connectors are relatively common press-on types — similar to an iPhone display — but they're



We believe this blank space, circled above, is for the hybrid cooling system absent from the 4.5-watt Core M3 model.

About iFixit

iFixit is a global community of tinkerers dedicated to helping people fix things through free online repair manuals and teardowns. iFixit believes that everyone has the right to maintain and repair their own products. To learn more, visit www.ifixit.com.

trapped under snap-on metal shields.

- The motherboard is so close, yet so far. Unable to wait, we skip to dessert and pop off some shields to get a closer look. The rest of the motherboard is nestled too snugly to investigate, but that SSD looks ripe for the picking. The Surface 4's Samsung SSD is considerably larger than the little whipper snapper we saw in the previous generation.
- The iOpener comes out for an encore, loosening the tough adhesive that holds the battery in place. It finally comes free after a great deal of sweat, tears, and prying. Not much has changed here — the adhesive is still extremely challenging.
- Repairability Score: 2 out of 10 (10 is easiest to repair). The SSD is replaceable. The battery is not soldered to the mobo, but very strong adhesive makes removal hazardous. Non-standard connectors make for tricky display removal, but it's not as hard as in previous generations, due to less stubborn adhesive. The display assembly consists of a fused glass panel and LCD, and is difficult to remove and replace. ■



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technotes

EPINIONS

"I have stripped down some chassis' so that the back now becomes the front. Not very pretty, but quite practical."



NEW PC TECH DESERVES NEW FORM FACTORS

Ever since the PC became a reality, the form factor has not varied very much. Just the latest connectors would be the difference. They are always at the back! Many times, I have wished that some of these connections would be at the front (or at least the side). I have stripped down some chassis' so that the back now becomes the front. Not very pretty, but quite practical.

The only case company I felt was starting to hear this dead quiet was Antec, which sold the Skeleton case. This somewhat gave the innards some decent access and changed the way I placed the unit in my workshop. But the power and reset remain at the front.

Can there be a discussion about the form factor? I would like to see the display, Ethernet, a few USB (for printer, scanner etc) all at the back, or an option to be otherwise. For all of the audio, multimedia and USB, be on a bracket with cabling to the motherboard. So the case would have a design that would give me the freedom to put those

connections on the front, on either side, or even at the back.

The outcome would be to park the case in spot, and not have to pull it out when I need to add or remove a connection.

David Taylor

PHONES AND COMPUTERS, THE GREAT DISCONNECT

There is a lot of hype about a phone being a computer in your pocket. Microsoft is one of the current leaders in this approach with W10 on all things and its phone Display Dock. So if a phone is a computer, why can't we manage our Windows 10 phone from our Windows 10 computer? As in – plug your phone into your computer as a peripheral so that you can make calls, write texts, manage your contacts, print documents and so on without going over the Internet (cloud)?

Maverick Patterson



Correction

Due to a production error, the 'Build a PC' story in the April issue of APC (see page 36) neglected to include specific step-by-step instructions on installing the CPU cooler. We've put together a revised story that corrects this oversight, which all readers can download as a free PDF at www.apcmag.com/magstuff.

APCMAG@FUTURENET.COM

Come on, have your say!

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Is the mixed-technology NBN really good enough?

Copper is increasingly being shown to be the more expensive option, so is it time to rethink the current NBN plan? Shaun Prescott reports.

The NBN debate shows no sign of abating, and Malcolm Turnbull's Coalition government is facing renewed pressure from peak organisations to rethink its MTM (multi-technology mix) approach, which combines extant copper lines with fibre optic cables. That won't be enough according to not-for-profit industry group Internet Australia, at least if the government hopes to catch up with connectivity standards put in place elsewhere in the West. Internet Australia CEO Laurie Patton is adamant that an FTTP (fibre-to-the-premises) implementation is absolutely vital – and that it won't cost any more than the MTM plan.

More specifically, the coalition's preference for FTTN (fibre-to-the-node) is not satisfactory according to industry and academic experts. The method, which mixes fibre cables with

copper, was recently discarded by United States Internet provider AT&T entirely, which has switched to FTTP.

Many believe that's what should happen in Australia, too, though there have been arguments against FTTP. For example, a FTTF (fibre-to-the-fence) approach is less of an engineering headache, some claim. It's still a huge infrastructure project, but it does provide some flexibility in cases where houses are dismantled and replaced, or a premises happens to be unconventional. And yeah, there's far less copper involved if you're connecting from your front yard rather than a node (imagine a telephone exchange) a couple of blocks away.

According to Mark Gregory, a lecturer in engineering at RMIT University, implementing an FTTP service is a better option for the long term. "The government should accept

the weight of international evidence and move back to fibre to the premises (FTTP)," he wrote in a piece for website The Conversation. "There is an urgent need for a 20- to 30-year life-cycle costing analysis to be completed to provide an engineering cost benefit justification for the NBN technologies to be used in the rollout."

That's the general tenor of most (authoritative) criticisms of the government's less-is-more approach to the NBN. And yet, FTTP on a national scale is something the government seems very reluctant to implement. And this despite the fact that according to a leaked NBN Co document (obtained by the *Sydney Morning Herald*), the company has successfully trialled a new multi-technology local fibre network which bypasses copper entirely – at around the same price. ■

ENDUSER

Share your stories!

If you have an interesting story about technology users, their experiences and the issues that affect us all (whether funny or serious), email us at apcmag@futurenet.com. All correspondence becomes the property of APC and is subject to editing. Letters must include writer's full name, street address, suburb, state and phone number to be considered for print publication. Address and phone details will not be published.



TABLET

\$1,499 | WWW.SAMSUNG.COM/AU

Samsung Galaxy TabPro S

Has Samsung managed to out-Surface Microsoft?

The TabPro S is one of the slickest 2-in-1 tablets we've ever laid our hands on. With an aluminium-alloy frame running around the outside edge and a body that's just 6.4mm thick, this Windows 10 device is thinner than most flagship smartphones. Weighing just 690g at its 12-inch size, it's reasonably comfortable to hold one-handed – that can't be said for many bigger tablets.

Using one of Samsung's Super AMOLED panels, the screen is gorgeous and fairly frugal when it comes to power draw, despite a 2,160 x 1,440-pixel resolution that matches the best at this size.

Inside, Samsung's gone with one of Intel's Core M processors that are specifically geared towards 2-in-1 devices like this – it's what's in Apple's mould-breaking 12-inch MacBook from 2015 – and although it's a lower-end Core m3-6Y30 chip working in combination with 4GB of memory, that's enough to

handle almost any productivity or entertainment task you might want, barring hardcore PC gaming. You won't be playing any first-person shooters or modern MMOs on this device – the Intel HD Graphics 515 GPU isn't quite up to the task.

For storage, you've got a LiteOn-made 128GB SSD that's average in terms of performance – it almost exactly matched what HP has in its similar Spectre x2 2-in-1.

Samsung has included a combined case/cover with the TabPro S that's mostly praiseworthy – it's a good combination of being easy to remove but comprehensive enough to turn it into a serviceable laptop and also protect the tablet's front and back from scratches. The keys are generously sized and the trackpad is just big enough so that it's not frustrating to use.

When in laptop mode, you can lock the screen at two angles and the key benefit

of the way the stand works is that it provides a flat base, meaning that, unlike the Surface Pros, you can actually balance it on your lap, so you can work with it while you're on the couch, sitting at a presentation or on public transport.

It's not perfect, though: there's no space between the back row of keyboard keys and the bottom of the screen, which isn't ideal from a comfort or screen-visibility perspective.

Still, with a battery life of around 5:30hr in our tougher battery PCMark 8 battery tests, you'll be able to type away for a good 1:30hr more than on a Surface Pro 4. We found the TabPro took around 3 hours to charge up if you're using it, 2.5 hours if you're not.

In fact, the TabPro S's only significant shortcoming comes in the form of a rather puzzling omission: no stylus. That's disappointing because, for all its improvements, Windows 10 isn't the best OS when it comes to interacting with

your fingers. There's still too many applications that don't offer touch-optimised equivalents: trying to move files around in Windows Explorer or select the smaller menu items in Office apps is a fiddly and frustrating endeavour.

Samsung does seem to have an upcoming optional C-Pen stylus that should be around \$90 locally, although it hadn't officially been announced at the time of our review. With that stylus, this could be a real Surface killer. Without it, though, it's stuck somewhere between an iPad and more professional-oriented devices. ■ Dan Gardiner

Verdict

Features ★★★★★
Performance ★★★★★
Value ★★★★★

A slick 12-inch tablet with a great screen, but without a stylus, it falls short of being a true Surface competitor.



✓✓✓
apc
RECOMMENDS

2-IN-1 LAPTOP

FROM \$1,799 | WWW.LENOVO.COM/AU

Lenovo ThinkPad Yoga 260

A business laptop with a modern twist.

Lenovo's ThinkPad Yoga 260 resembles the previous Yoga 12, but benefits from upgraded specs and a sharper design. The colour scheme is typical ThinkPad, making it ideal for business use. It's dominated by either black or silver material, from the carbonfibre lid to the magnesium-alloy base, which is broken up by red on the left and right with dedicated clickpad buttons and pointer.

At 12.5-inches, it is more compact than most 13-inch laptops and slips into a bag easily for transportation. Its front edge features a slanted design that makes it feel less box-like than the Thinkpad Yoga 12.

As with most convertibles, the display has fairly chunky bezels, which makes the device easier to hold in tablet mode.

Thankfully, Lenovo resisted the urge to equip this machine with Intel's Core M processor. They instead opted for Intel's

more capable Intel Core i3, i5 and i7 sixth-generation Skylake processors, which are equipped to handle most demands.

However, those full-fat CPUs mean Lenovo struggled to keep the 260 compact; it's 1.8cm thick and it tips the scales at 1.32kg. The 260 is also highly configurable. Windows 7 Professional 64 is offered as a pre-installed downgrade option, accessible within Windows 10. It's also available with a range of solid-state drive options, all the way from a standard 128GB SATA 3 drive right up to a faster 512GB PCIe-NVMe SSD.

Additional extras include Microsoft Office, Adobe and McAfee subscriptions, and an optional smart card reader for physical authentication scenarios.

This machine has a good selection of connectivity options, too. They include two USB 3.0 ports, HDMI, mini DisplayPort and an SD card slot. The number of ports can be extended using

Lenovo's OneLink+ dock to add USB, Gigabit Ethernet and extra display ports while charging the battery.

The display's matte, anti-glare finish does a good job of keeping reflections to a minimum, but it's less effective at preventing fingerprint marks.

While 1,920 x 1,080 is a suitable resolution, fonts and menu labels are a little smaller than what you might be used to. Graphics duties are taken care of via the Intel HD 520 solution inside, and is suitable for low-level image editing and modest graphics work.

This machine comes with a stylus. Whether drawing in Fresh Paint or picking out icons on the desktop, it's a pleasure to use. Docking the pen in the machine also recharges it.

ThinkPads are known for their comfortable keyboards, and the Yoga 260's doesn't disappoint. It offer the right amount of travel and feels soft due to its convex shape and subtle cushioning underneath the

keycaps. They also benefit from generous spacing, which makes for a more natural typing experience.

The 260's clickpad is smooth and large enough to use Windows 10's swipe gestures comfortably.

This machine is definite evidence that Lenovo is getting better at combining the reliability of traditional ThinkPads with the modern features that we've come to expect from its Yoga range.

If you can put up with the bright yet average-looking display and mediocre battery life, there's a versatile and feature-packed laptop waiting for you here. ■

Verdict

Features ★★★★★
Performance ★★★★★
Value ★★★★★

Gorgeous IPS panel; kitchen-sink feature set; funky design.





"While the XPS 12 is a brilliantly designed product, there are some caveats to this."

2-IN-1 LAPTOP

FROM \$1,999 | WWW.DELL.COM.AU

Dell XPS 12

Dell puts a clever (and flawed) spin on the 2-in-1 laptop.

The Dell XPS 12 is one of the most divergent Windows tablets to come out in recent years. But this beautifully sophisticated device is also one of the strangest 2-in-1 laptops around.

Like many hybrid devices before it, the XPS 12 is made up of two parts that split into a 12-inch tablet and a keyboard section called the Premier Base. But there is seemingly nothing holding the halves together. The screen merely slots in place with a groove cut into the base. It works surprisingly well. Through the forces of gravity, friction and a few magnets, the base holds the top section of the device in place while allowing you to lift it off.

However, because there's no hinge, you can forget about tilting the screen to your liking, as it remains at a fixed 110-degree angle while docked with the base. Dell conducted research to find the angle at which most users tilt their screen.

You can close the XPS 12 and confidently know the screen will be held securely in place by the Premier Base. Alternatively, you could flip the tablet section over, so the display is face up and at a slight angle for drawing with the stylus. There's no risk of the screen falling off when you have the machine tilted back because the base's rear hooks slightly to catch it. Unfortunately, there's nothing to stop the tablet from tumbling forward.

Dell was only offering a single version of the XPS 12 at the time of print — one with a Core m5-6Y57 CPU along with 256GB SSD, 8GB of memory, Intel HD 515 graphics and a top-shelf 4K panel in that 12.5-inch screen. That makes it slightly higher-specced than average for a 2-in-1 this portable, but the downside is that it's priced at \$1,999 — a good deal higher than some of the lower-spec models on offer in the US and UK.

In the box, Dell's bundled in an additional magnetic

fabric cover, as well as an alternative 'slim' keyboard cover that turns the XPS 12 into a Surface-like device. The Slim Base lives up to its name with a fabric-lined exterior, backlit chiclet keyboard with 1.3mm travel and a glass trackpad.

As a tablet alone, it's marvellous, and we're not just talking about the premium sheet of Corning Gorilla Glass on the front of the slate. It's as thin and light as Dell's Android-powered Venue 10 tablet, but in roughly the same-sized package, you're getting a fully capable Windows 10 machine.

The XPS 12's Premier Base is outfitted with a keyboard that feels as tactile as the firm's business line of Latitude laptops. The keys are much larger than what you might be used to seeing on 12-inch devices. Each key is slightly concave to match the curvature of your fingertips while offering 1.9mm of travel. The glass touchpad is a bit on the small side, but it's

extremely smooth and recognises multi-touch gestures.

The XPS 12's speakers are impressive, thanks to their forward position and having room to vibrate along the top bezel.

Weight is a trifling matter. As a standalone tablet, it weighs a mere 790g and the chunky Premier keyboard only bumps up the device's load to 1.27kg.

However, you won't be playing many games and expect your run times to top out at five hours.

In the end, the XPS 12 just isn't as versatile as it promises to be. ■

Verdict

Features
Performance
Value



An unconventional design proves to be both a boon and a bane to this pricey 2-in-1 Windows device.



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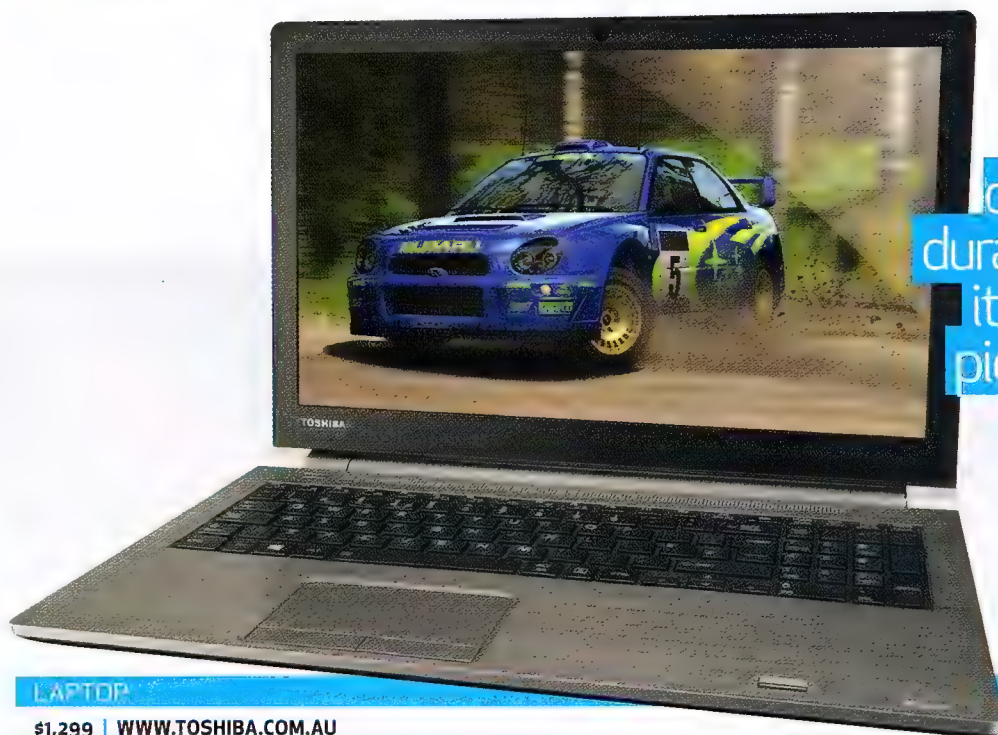
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"This machine's claim to fame is its durability and, indeed, it is one solidly built piece of computing."

LAPTOP

\$1,299 | WWW.TOSHIBA.COM.AU

Toshiba Tecra A50-C

A midrange laptop with midrange features.

The Tecra A50-C is the laptop you don't have to worry about. Throw it into your suitcase. Splash coffee over it. Knock it off your desk (accidentally, of course). Just don't play games on it. With its lower-mid price, Core i7-5500U CPU, 4GB of RAM and 500GB hard drive, this 15.6-inch unit thinks of itself as an all-work, no-play laptop.

Its matte black exterior is grooved with fine parallel lines that are reminiscent of woodgrain. Its screen lies tight against its base when closed, which gives the laptop a slim profile. Its exterior edges are glossy, plastic and embedded with multiple ports. Inside the keyboard is a full number pad and the touchpad sits left of centre.

Despite its significant footprint, at 2.27kg the A50 handles like a lighter laptop, as its weight is evenly balanced over its frame.

The Tecra maintains its balance even when open. Shifting laps and wobbly

desks do not perturb it; tilt its screen all the way back and its strong hinges will prevent any flopping or tipping. The superb balance and hinge strength were some of our favourite aspects of this laptop.

However, the touchpad would benefit from more surface area – its size makes scrolling tedious. But since the touchpad occupies so little space, you won't have to worry about 'palming' while typing. It's responsive with clicky buttons that provide good feedback. Multi-touch, however, is not responsive at all. Two-finger scrolling is temperamental – when it's in the mood to help, it's either laggy or it misreads your intentions.

Pinch-to-zoom works a little more often, but its imprecision ultimately makes it impractical. After much experimentation, we gave up on multi-touch.

This machine's claim to fame is its durability and, indeed, it is one solidly built piece of computing. Its base

is firm and compact. And while the keyboard may not be well-designed, it is at least spill-resistant. We wouldn't recommend dipping it in the bathtub anytime soon, but if you knock your open water bottle onto it, you'll have time to save your files before the water wipes out your work.

The only part of the laptop that feels flimsy is the screen. We repeatedly stepped on the laptop (when closed) to test its durability and the screen exterior's flexibility prevented any cracking or splitting.

The 1,366 x 768 resolution screen is underwhelming. The colours are flat and its backlight puts out minimal brightness. Lucky for Toshiba, there aren't many great competitors at this price. If you're going with a Tecra A50-C, we recommend forking out to upgrade its screen to 1,920 x 1,080, not only for the increased resolution, but for the enhanced brightness.

But when it comes to

ports, you'll find everything you need here, including a VGA port and Ethernet jack.

In our test, the swappable battery lasted 4 hours, and when we played a full-screen 720p movie continuously on 50% brightness, it lasted 5 hours and 36 minutes. The Tecra A50-C also runs very quietly and maintains a cool temperature.

Users who value a great external build and port diversity might love the Tecra A50-C at this lower-midrange price. But those who don't will find that there are more budget-friendly options available. ■

Verdict

Features
Performance
Value



It's optimised for work rather than play, but this utilitarian laptop still has lots to like.





LAPTOP

\$1,499 | WWW.HP.COM/AU

HP Envy 13-d001TU

An enviable proposition, pity about the average battery life.

The Envy Notebook 13 clocks in at a super-slim 12.9mm, undercutting the fat edge of a 13-inch MacBook Air by 4.1mm. Under the hood, there's the new Skylake i7-6500U processor. Encasing the Envy's screen is tough, brushed aluminium. The overall look is professional and looks more expensive than its price tag. While the base is plastic, to the casual eye, this would likely go unnoticed.

The much-lauded (by HP) hinge has been designed to give the keyboard an extra boost at the back creating a better typing position. Desk-based users will immediately warm to this feature as it reduces RSI and finger fatigue.

Although not as bad as some, touchpads on HP laptops are often less reliable and more erratic than others. The keyboard also has a design quirk in the form of the hash key, which lies directly between the backspace and

Enter buttons. If you're used to an L-shaped Enter key, you're going to have a lot of lines ending in '#'. The keyboard does have redeeming qualities – it's backlit and features a very reliable fingerprint scanner.

The HP Envy 13 has a 1080p display and at 8GB, it also sports double the memory of a stock 13-inch MacBook Air. When you look at it this way, the Envy has value for money in spades.

We loved its zippy boot and shutdown times. It fared well in the CineBench OpenGL benchmarks. Not only does the faster processor help boost this, but the onboard graphics chip (Intel HD Graphics 520) also runs 1,000MHz faster than the Intel Graphics 5500 solution found in many older laptops still on the market.

The screen is bright and viewable from all angles. Its white and lighter colours are a little dull at mid-brightness levels but this isn't noticeable when watching movies. It's no Retina Display but it's an

above-average screen for this price tag.

The battery benchmark registered a disappointing 3 hours 30 minutes, which is nearly an hour less than the Dell XPS 13. HP claims a maximum of 9 hours of productivity, but you would struggle to achieve that.

Finally, there are also some pre-installed programs: McAfee LiveSafe Internet Security (HP's standard bundled antivirus software); HP Lounge (HP's own entertainment hub, a little like Spotify); and HP SimplePass (Software to run the fingerprint scanner)

The Envy is light, portable and resilient. While it's not a complete aluminium build the non-metal parts don't feel flimsy. The wide touchpad is welcome and the keys themselves feel sturdy with few dropouts.

The full HD screen has a wide viewing angle with a good colour space. The new i7 processor proved itself in the benchmarks and the price point is good value.

The faults we found were

mainly physical. The placing of the hash key and shape of the Enter key are eccentric and take a little getting used to. In general use, the touchpad would occasionally zoom in instead of scroll. The battery life wasn't quite up to scratch.

We wanted to love HP's thinnest laptop. It has all the hallmarks of greatness, almost MacBook Air physical specs, and a consistently well-performing new CPU.

But if you're looking for something light and portable with processor oomph coupled with an FHD screen then the Envy might just be for you. ■

Verdict

Features
Performance
Value



A respectable if perhaps uninspiring 13-inch all-rounder. Not the best example, but far from the worst.





SINGLE-BOARD COMPUTER

\$60 | WWW.RASPBERRYPI.ORG

Raspberry Pi 3

The latest course served up from the Raspberry Pi Foundation.

It's been four years since the Raspberry Pi blasted onto the single-board computer scene. To celebrate, the Raspberry Pi Foundation released its latest version, Raspberry Pi 3, which is more of an evolution than a revolution.

Powered by a BCM2837 SoC (System on a Chip) and featuring a 64-bit ARM Cortex A53 quad-core processor running at 1.2GHz, the Pi 3 has quite a powerful processor. However, there's no RAM upgrade this time, which leaves it with 1GB. A subtle upgrade on Pi 3 is the usual VideoCore IV, which handles video and graphics now clocking in at 400MHz compared to earlier models at 250MHz.

Physically, the Raspberry Pi 3 looks very similar to the Pi 2; the only noticeable changes are the locations of the status LEDs and a new chip on the underside. This chip is the BCM43438, which provides Wi-Fi b/g/n

and Bluetooth on the board, and removes the need for USB dongles. Bluetooth 4.1 provides both a classic and low energy (LE) method of connecting to devices. Bluetooth LE is an exciting prospect as it enables low-power hardware applications, like beacons, that can interact with devices such as tablets and smartphones.

The antenna used for wireless communications is located on the outer edge of the board, just out of the way of any add-on boards that may interfere with the signal. In our tests, we found the Wi-Fi to be as sensitive as the official Wi-Fi dongle and as easy to use. Built-in wireless communications is a big deal for the Raspberry Pi and enables it to be used as an IoT platform for very little outlay. To use these new wireless components, you'll need to update your Raspbian image to the latest version or download and flash the latest image to an 8GB or larger micro SD card.

The latest Raspbian image also comes with refinements needed for the Pi 3, such as new firmware that will enable the Pi 3 to run at full capacity. The new wireless features do come at a cost: the Pi 3 consumes nearly one and half times more power than the Pi 2. This means that the Pi 3 needs a reliable power supply, with a recommendation being a 2.5A supply when used with add-on boards that use motors or neopixels.

The Pi 3 comes with four USB ports and an Ethernet port, which provides Fast Ethernet, 100Mbit/s, and is routed via the LAN9514 chip, which has been the standard since the Model B+ Pi was released in mid 2014. Many have criticised this decision as it prevents the use of Gigabit Ethernet, but adding that would have increased the cost.

The Pi 3 provides an incremental speed increase when compared to the Pi 2, figures quoted by the Foundation state around

50-60% when running 32-bit code on the new processor. Current OSs don't yet use the chip's 64-bit mode; and the speed boost is mainly due to a series of architectural enhancements.

The Raspberry Pi 3 is a remarkable piece of technology. It builds upon a rich community of support and maintains a level of backwards compatibility. The arrival of wireless communications enables IoT projects at a lower price point and helps provide a platform for tinkering and experimentation.

■ Les Pounder

Verdict

Features	★★★★★
Performance	★★★★★
Value	★★★★★

Building on the legacy created over the last four years, this board will power many more projects to come.





BATTERY CASE

\$165 | APPLE.COM/AU

Apple iPhone 6s Smart Battery Case

Don't fight the bulge, embrace it!

Everyone wants to eke out a fraction more battery life from their iPhone. Well, with this case for iPhone 6 and 6s, you can. The case incorporates a 1,877mAh battery, which can just about double your iPhone's capacity. Battery physics means this doesn't always get you to 100% again, but it certainly prolongs the juice for a while longer; Apple claims an increased talk time of up to 25 hours. Integration with iOS means you can easily check the battery status from the Lock screen or the Notification Center.

There's a knack to slipping your iPhone in and out of the case but it's easy once you've got used to it; the soft microfiber lining also means you don't have to worry about scratches.

The fit is certainly snug and secure, and the soft-touch silicone feels great in the hand — smooth, but with some friction for grip. The bulge on the back does look a bit out of place, but it

actually provides a nice grip and rest point. The case inevitably adds weight, but considering the impressive battery life, an extra 102g is not too great a sacrifice. They also come in a variety of different colours.

The use of a Lightning connector is of little consequence if you charge your iPhone using a cable, and if your bedside dock has Lightning, slipping your encased phone on it is a boon. We found that Apple's own EarPods fit okay with the case; others may not fit so well, though, and there's no adapter.

The bottom line is that this case adds a bit of bulk to your iPhone, but isn't that a price worth paying for much-prolonged battery life? ■ Christopher Phin

Verdict

iPhone 6 and 6s only; microfiber lining and silicone exterior; charges simultaneously with phone



KEYBOARD

\$149 | WWW.LOGITECH.COM

Logitech Create Keyboard Case

Can Logitech beat Apple's own iPad Pro keyboard case?

Logitech's iPad products are generally great. Between this and Apple's Smart Keyboard, Logitech's has the more traditional feel to its keys, so you can just start using it without retraining your muscle memory. There's not as much travel and bounce as from Apple's non-Magic Mac keyboards, but it's eminently useable.

The layout is pretty similar between it and the Smart Keyboard too — both use the extra size to avoid having to squeeze in punctuation keys — but we like that the Create has its arrow keys in an inverted 'T', while Apple's keyboard just fits them into an awkward rectangle.

Perhaps the biggest advantage is its dedicated keys for playback, volume, lock, Home screen and so on, which are absent from Apple's keyboard. The last of those is better than the Command-H shortcut, because it can also return you to the first Home screen

when you're on a later one. Three-level backlighting is also welcome, despite being uneven across the keys.

It's not all good, though. Compared to the Smart Keyboard, it's notably heavy and bulky. Worse, it's a pain to fit and remove from the Pro, though it does cover the iPad's back, too. It's fine if you always want to have a hardware keyboard attached to the Pro, but tiresome if you want to be more flexible. It covers the speakers as well; not ideal.

We want to love this comfy, feature-packed keyboard, but it's a hassle to fit. However, it's good if you'll use your iPad Pro more often as a laptop than a tablet. ■ Christopher Phin

Verdict

It's tricky to fit, but if you don't plan on removing it very often it makes a fine keyboard and case.





GAMING PERIPHERAL

\$130 | WWW.RAZERZONE.COM

Razer Tartarus Chroma

An enthusiast gaming accessory that isn't quite hardcore enough.

Keypads have added multitudes more 'standard' keys since their introduction 15 years ago and their main appeal is that they offer a more comfortable, configurable alternative to typing-optimised keyboards, putting lots of keys and controls in positions that are easy to use one-handed. Belkin long-ago handed its Nostromo design over to Razer and it lives on in the latter's products.

The Tartarus Chroma is Razer's recently-upgraded entry-level option, which is meant to cover the basics. There are three rows of main keys (15 in total) plus a thumb control area with HAT switch and two buttons. Those main keys aren't mechanical, using rubber membrane switches that are, physically, a little resistant and bouncy when pressed – to us, the Orbweaver's mechanical switches were far more comfortable and still had enough tension behind them that you can

rest your fingertips on them.

Actually, the Tartarus' main problem is one of design rather than quality: there just aren't enough standard keyboard keys. Most modern MMOs and even FPSs are control-intensive, needing 20+ keys. Having only three rows of five keys means you're constantly short, and unless you remap the HAT (which is a little hard to use reliably, requiring you to stretch your thumb), you'll subsequently have to reach across to your normal keyboard to tap a button you didn't have room for on the pad, which defeats half the purpose.

If you're going to splurge on a gaming keypad, you might as well get one with enough buttons to do the job properly. ■ Dan Gardiner

Verdict

It works, but really needs more keys to tackle today's control-intensive games.



GAMING PERIPHERAL

\$200 | WWW.RAZERZONE.COM

Razer Orbweaver Chroma

How to build a better gaming keypad.

We don't usually recommend going for top-shelf tech here at APC – it's generally more sensible to take a step or two down, which nets you most of the features and performance for a lot less dosh. However, gaming keypads might be the one area where we make an exception.

With 20 primary keys with mechanical switches behind them and lots of customisability, the Orbweaver is genuinely hard to fault.

The wrist-rest, palm pad and thumb controls are all able to have their positions tweaked, moved back and forward so they closely mould to a variety of hand sizes. And as on the Tartarus, the function of every key can be remapped to any keyboard or mouse button, programmed with a macro or even disabled completely. Getting the perfect setup for each game can take a little toing and froing, but when you get it right, the payoff is

a frankly keyboard-beating level of comfort and convenience.

The Orbweaver doesn't overcome the keypad's problem of remembering what keys you've mapped where – they're numbered plainly 1 through 20 – and although you could customise individual key backlights to make things a bit more synaesthetically memorable, that's not ideal when you should be looking at the action onscreen. This does get better over time, however.

Before you rush out and buy one, though, the non-Chroma version of the Orbweaver costs around \$130 online – so if you can do without the lighting, it's definitely better bang for buck. ■ Dan Gardiner

Verdict

A fantastic, albeit costly, gaming keypad that does little wrong.





GAMING HEADSET

\$160 | WWW.CORSAIR.COM

Corsair VOID Wireless

An intriguingly-designed gaming headset that needs refinement.

Losing the cable is great – it gives you the freedom to move around and not get tangled up. On the other hand, wireless headsets are battery-dependent, and the quality and comfort can be lackluster.

Our VOID was lightweight and comfortable. The circumaural ear cups did feel a little loose; there just wasn't enough tension on the underside of the cups themselves. The build quality is good – its mainly plastic body hides a strong aluminium band running along the top of the headset. The adjustment range is good, with both ear cups capable of swiveling up to 90 degrees, and the headband is more than roomy enough for even the largest of skulls.

As for sound quality, it's what you'd expect from a USB headset. And for the price, we're impressed. The soundscape is crisp and

bouncy, there's a fraction of sibilance once the volume's turned up to the higher echelons, but all in all, it's really good. The bass is well rounded, too.

The mic quality is great, recordings sound precise and accurate, but it's not adjustable. Noise canceling isn't great, but it's not terrible either. On the other hand, the LED display included in the mic just seems gimmicky to us.

Finally, RGB LEDs are discreet and out of the way; however, they still fall prey to that one colossal problem unique to headsets: you can't see them.

Overall, though, they're a joy to use. ■ Zak Storey

Verdict

Good sound quality and intuitive design create a comfortable and well-priced wireless headset.



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MOBILE PHONE
\$1,149 (32GB) | WWW.SAMSUNG.COM/AU

Samsung Galaxy S7

Putting the Galaxy back on top.

Samsung's Galaxy S6 was met with a mixed response in 2015: critics praised the design, but lamented that it had come at the cost of features like the microSD card slot, removable battery and waterproofing. And whether it was because of those complaints or just from a general sense of fatigue from smartphone buyers, Samsung's 2015 smartphone sales didn't perform anywhere near the company's expectations.

So for the new S7, Samsung has brought back the microSD and waterproofing to go with an even classier aluminium-and-glass chassis, unbeatable 1440p 5.1-inch AMOLED display, speedy fingerprint security and requisite under-the-hood upgrades (which for Australians means an octa-core Samsung Exynos 8890 CPU, Mali-T880 GPU, 32GB of storage and 4GB of RAM).

There's very little to complain about here. Even Samsung's oft-bloated OS is decidedly restrained – there

are less preloaded apps and the TouchWiz UI is a little more polished and mature. The 12MP camera's the best we've tested on a phone, with outstanding low-light performance and great, vibrant colours.

The only performance-related issue we found was a tendency for the back of the phone to get warm if you've been gaming intensively or for long periods. The S7 is still mostly comfortable in the hand with curved edges on the back making it easier and more secure to hold.

This is, again, Samsung's best Galaxy phone ever – and this year, there's basically no 'buts' to that statement. If you want the best smartphone currently on offer, this is it.

■ Dan Gardiner

Verdict

Class-leading in almost every regard, the S7 shows off Samsung at its very best.



MOBILE PHONE
\$1,249 (32GB) | WWW.SAMSUNG.COM/AU

Samsung Galaxy S7 Edge

Samsung has honed its design to produce a sharper Edge.

Samsung has put a great deal of energy into making the S7 Edge its own device and distinguishing it from its sister S7, with the addition of an 'edge drawer' toolbox to giving the screen curve more practicality.

Like the S7, the most notable upgrades on this new phone are the reinstatement of the SD card slot and full IP68 dust and waterproofing. The slightly curved back panel adds to the appeal and makes the phone feel much nicer in the hand.

The battery is now 35% bigger than its predecessor at 3,600mAh, meaning it'll easily endure a full working day's use and, like the S7, quick-charges in 95 minutes. The added processing power from Samsung's Exynos octa-core 2.6GHz and 1.6GHz processors, 4GB of RAM and an impressive-looking 1440p AMOLED display round out the powerful and future-proof hardware.

Though for the most part, the curved screen edges are a positive attribute, they do occasionally slice the other way. The new curved back panel means an even thinner strip of metal runs down each side – it's so thin, your fingers and palms have a tendency to curl around the device and accidentally creep onto the touchscreen, rendering it unresponsive to other deliberate taps.

There's a lot to offer in this exceptionally well-groomed flagship and, like the regular S7, there aren't many ways to fault it. The price and size difference between the two phones should make choosing between them a bit easier – but whichever way you go, you won't regret the decision. ■ Joel Burgess

Verdict

An exceptionally well-balanced smartphone that may even have an edge on the iPhone 6S Plus.



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software

» APPS FOR ALL THE PLATFORMS



Windows SOFTWARE

Vivaldi

The self-described 'browser for power users' hits version 1.

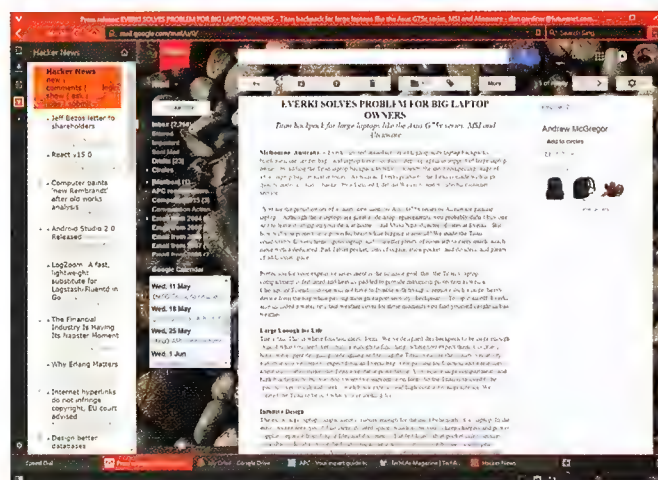
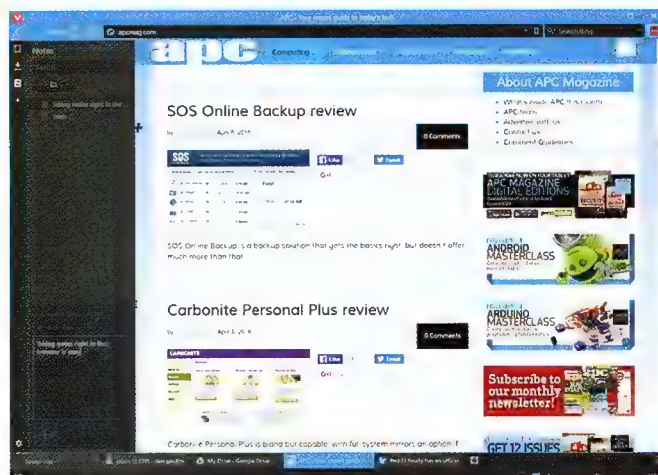
FREE | VIVALDI.NET



We first looked at Vivaldi a little over a year ago, when it was released in its first preview version. The devs are pitching the app as being for power users. Largely, that means lots of inbuilt tools and customisation options; the developers aren't really interested in the minimalist direction. Vivaldi has an expanding toolbar on the left-hand side, with quick access to your bookmarks folders, downloads and a built-in text editor that lets you quickly take notes or save web text.

Customisation goes much deeper than that, though: you can have your tab bar at the top, bottom, left or right (opting for the sides will display open tabs as large thumbnails) and the dedicated search box has five preconfigured options built in (Google, Bing, Yahoo, DuckDuckGo and Wikipedia) with the ability to add as many more as you like. There are keyboard shortcuts and trackpad gestures, an integrated content blocker that did a reasonable job of blocking ads (although doesn't appear to be customisable in any way — we couldn't find anything about it in Vivaldi's settings) and there's even the ability to load a page without images, potentially great for saving bandwidth for when that matters. There's also compatibility with most Chrome and Firefox extensions — that included our personal essentials, including the LastPass password manager and Pocket for saving stories.

It's also fairly reasonably on system resources — about 10-15% more frugal than Chrome in our tests. In short, if you're sick of the big-name browser options, there's a lot here that should appeal. Definitely worth a try. **Dan Gardiner**



Google Nik Collection

FREE | GOOGLE.COM/NIKCOLLECTION/

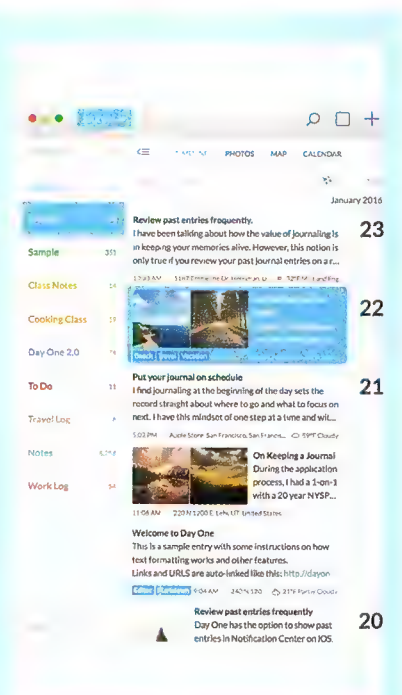
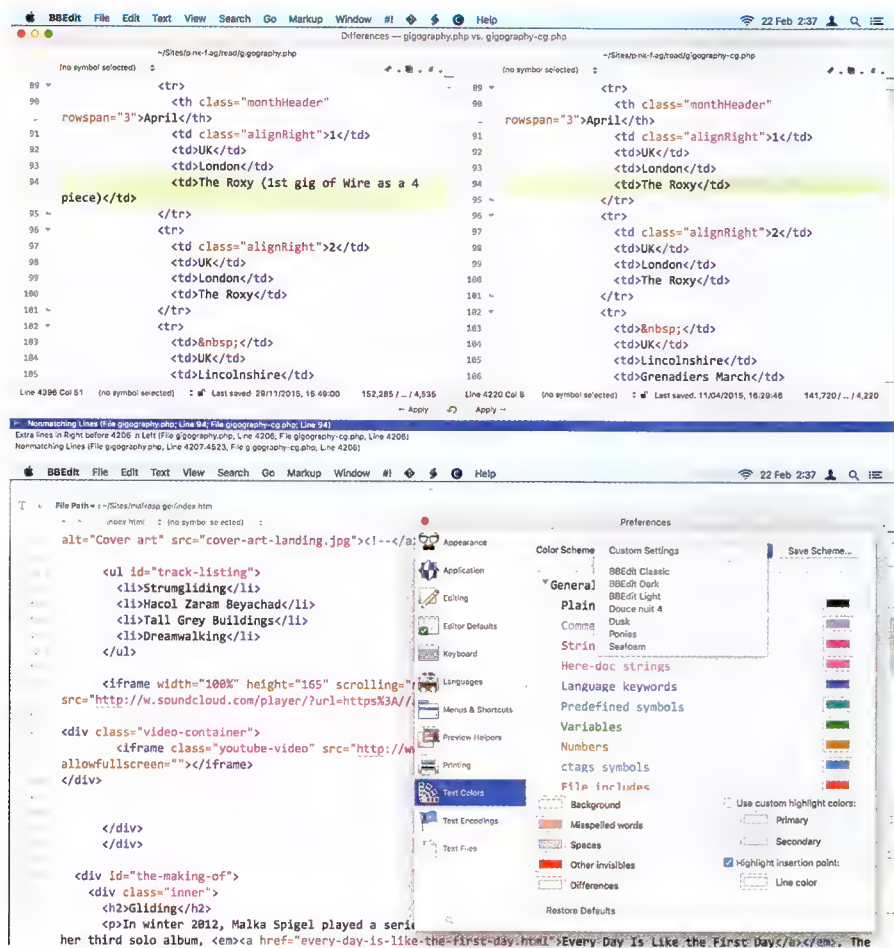


While we generally only cover standalone applications in our monthly software round-up, the Nik Collection is a bundle of add-ons that's worthy of highlighting because of the value on offer. Google bought this image-editing collection four years ago (ostensibly to get at the smartphone photography application Snapseed) and at US\$150 value and now gone free, it's just too good to pass up. Each of the seven desktop apps probably wouldn't be quite intriguing-enough individually to justify a write up, as they're intended for use by enthusiast and professional photographers or designers to do very specific photo manipulation tasks. Basically, each app in the Nik Collection is a filtering tool that has a number of useful preset filters, but will also allow you to apply your own custom settings. An analog image effects suite, an advanced colour enhancement palette, a definition tweaking tool, black and white image editor, a tonal adjuster, HDR image blender and a sharpening tool round out



the seven apps of the Nik Collection. They're surprisingly simple to use for a professional-grade tool and now that they're all available for free, it's hard to see why you wouldn't grab the set. **Joel Burgess**

Mac » APPS



Day One 2

\$46.99 | DAYONEAPP.COM
REQUIRES OS X 10.10 OR LATER



Day One has had an unassailable lead over other journaling apps for 5 years, thanks to

its elegant approach to digital diary keeping. Day One 2 tries to improve on the original's tag-based organisation and metadata smarts with some welcome new features.

The overhauled interface loses the big-buttoned sidebar and moves all functions to the top of the journal window for a cleaner, Evernote-like look, but the big change is an option to keep multiple journals, which live in a collapsible left-hand pane. A new Photo view option sits above the entry pane and lets you browse journals visually, while additional timeline filters and a multiple entry selection option add to the ease with which you can manage your thoughts.

The app uses a proprietary sync service, but drops the iCloud and Dropbox support of Day One. Users who have been victims of data loss may applaud the move, but Day One Sync currently lacks end-to-end encryption.

Overall this is a solid sequel; however, existing users may find the cost of updating a bit steep.

Tim Hardwick

BBEdit 11.5

Do we really need another update of this veteran text editor?

US\$49.99 | BAREBONES.COM | REQUIRES OS X 10.9.5 OR LATER



When an app's about to celebrate its 25th anniversary, you might wonder what's left to

improve with this text editor.

Developer Bare Bones Software claims more work has gone into version 11.5 than for any previous release outside of a major upgrade. On the surface, this may not be readily apparent. BBEdit 11.5 on launch not only seems familiar, but broadly identical to its predecessor. But start working with it or exploring menus and you'll notice dozens of little changes.

For example, app support and setup items can be shared over iCloud Drive. Click to select an item and underlines still match instances within the

content window, but now the vertical scroll bar also flags such terms. Plus, there's a Start Speaking menu item, for reading a window's contents to you.

BBEdit 11.5 comes across as a shining example of an app where small changes make a big difference. If you've been away for a while, you will notice the more significant updates in BBEdit 11 — major speed increases; streamlined workflows; improved search-and-replace; better Clippings; overhauled syntax colorings; superior Find Differences.

However, it still has a tendency at times to feel a little inelegant, but BBEdit's changes continue to be meaningful, and the app remains first-class. **Craig Grannell**



App Store » iOS APPS



ProCam 3

A huge collection of shooting and editing tools.

\$7.99 | IOS 8 OR LATER | PROCAMAPP.COM



Like many other 'pro' camera apps, ProCam lets you set exposure, shutter, ISO, focus and white balance manually (in a fiddly but usable manner), as well as changing the aspect ratio and showing a range of grids to help compose dynamic shots. You can save in TIFF rather than JPEG, turn geotagging on/off, and burn copyright and/or location info into the picture itself. Some features miss the mark for pros, however. But there's loads of useful stuff bundled in.

There's a slow shutter mode, with presets for motion blur and light trails, the option to reduce the shooting resolution of video (4K unlockable via in-app purchase), the ability to add background music when editing video, and frame extraction. Some of the options and filters seem a bit pointless, but there are useful tools, such as perspective distortion correction. We wish the app looked as polished as Camera+, though, and there are some feature and interface gaffes, but there's a lot on offer.

\$7.99 isn't much for such a broad collection of tools, even if the selection is sometimes a little random. **Christopher Phin**

Airmail

\$7.99 | IOS 9 OR LATER | AIRMAILAPP.COM



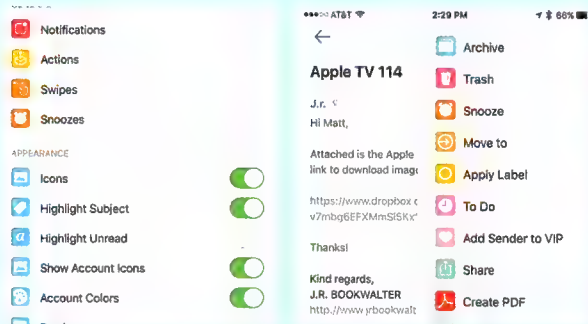
Airmail is a third-party email client that checks off nearly everything on our wishlist (and then some). Nearly everything we liked about Airmail for Mac is present here, including message snooze capabilities and bulk editing. There are also plenty of nice touches, such as the ability to attach files from popular cloud services or send details to other apps.

If you're already using Airmail for Mac, getting started on iPhone is a snap with iCloud sync. Handoff allows users to start composing a message on iPhone, but finish up on Airmail for Mac (or vice versa). The app excels at composing emails, with rich text formatting options that appear in a row above the keyboard. Airmail works natively on Apple Watch.

Almost every nook and cranny of the app can be tweaked and tailored to your specific taste.

The most obvious missing feature is support for Notification Center — the Mac version has it, so presumably the developers will introduce it at a later date, hopefully alongside native iPad display support. There's also no push for POP accounts, a feature also in the works.

JR Bookwalter



Interact

\$7.99 | IOS 9 OR LATER | AGILETORTOISE.COM



Once you've found your way round, this app offers some of the key features sadly missing from Apple's built-in Contacts app. For example, one of the app's standout facilities is Scratchpad, which enables you to copy text from email signatures, websites and other apps and paste them into a new contact. It's just not immediately obvious where it is. (It's the stick figure with lines.)

One of the biggest omissions in the Contacts app is the fact you can't create a group. Well, in Interact you can. There are Message and Mail icons, and an additional Text option. Basically, all that the app has to offer is good, it just could be laid out a little more clearly — although you can get guidance from within the app or from the website. The app works best for contacts stored on your iPhone or in iCloud; however, it does support contacts synced with Google and other services.

Initial navigational issues aside, there are some really useful features here — features that should come as standard on iOS! **Jo Membery**



Google Play » ANDROID

MSQRD

Face off... or on.

FREE | WWW.MSQRD.ME

MSQRD While the name doesn't exactly roll off the tongue, squint a bit and you'll see it's a vowel-less version of the word 'masquerade'. Apt, as this app replaces your own face and swaps it out for just over a dozen others in real time.

It's beyond simple to use: put your face into the outline on screen (or someone else's if you want to use the rear-facing camera and have a laugh), and the app immediately puts a new one over the top. It cleverly animates the mask as you talk, though it's a little unnerving to see a tiger's mouth where yours should be, and the panda (we think it's a panda anyway) looks utterly bizarre with human teeth poking through.

As fun and surprising as it is, Android users are missing out, as the iOS version has many more masks (including an eerie 'face swap' which needs you and another participant). However, MSQRD is in beta on Android, so expect the full roster soon.

Paul Taylor



WP10 Launcher

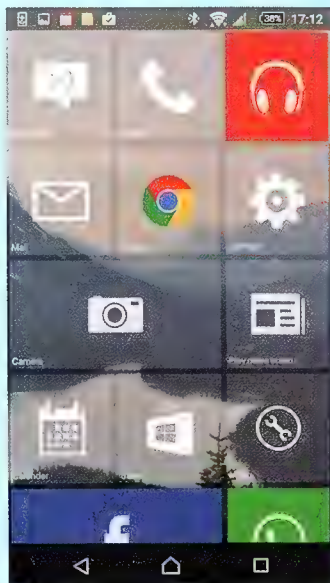
FREE | TINYURL.COM/APC428-WP10



One of the coolest and most useful features of Android is the ease and extent it can be customised. WP10 Launcher essentially reskins your phone to behave more like a Windows phone — ideal if you've ever craved the third-largest operating system but couldn't pull the trigger and actually commit. We recommend downloading WP10 Launcher to get a taste of what you're missing, and you'll either be intrigued by the flavour or so repulsed that you'll never want to give the real thing a shot. WP10

Launcher only activates when you hit the 'home' button, overlaying Windows-style tiles in place of app icons which can then be 'unpinned' (removed from the home screen) or resized to give more screen real estate to the apps you use the most (or want easiest access to). Looking for the rest of your apps? Flick left and you'll get an alphabetised list of your apps, from which you can pin to start (add to home screen). It's rough and littered with spelling mistakes, but it's as good an intro as any.

Paul Taylor

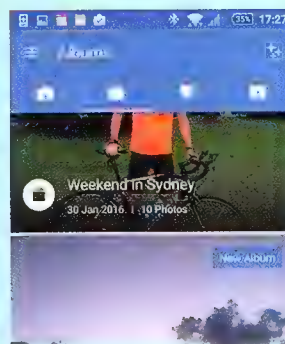


Everalbum

FREE WITH IAP | WWW.EVERALBUM.COM



Backing up your photos? You should, and it's an easy process to automate. Everalbum joins a litany of apps — free and paid for — that offer limitless storage. An enticing prospect, though one that comes with a few conditions and limitations. Everalbum will happily stash away low-res versions of your pics. What 'low-res' means in this case is nebulous, but for some indication, we found it converted a 11MB, 5,520 x 4,140 pic to a 298kB, 1,500 x 1,125 image. Video is exclusively reserved for Everalbum Plus, along with 'full-res' photos, and customer support, though at time of writing, this will cost you \$11.44 per month, fluctuating depending on currency conversion rates. If you have money to spend, you'd be better served looking at Dropbox or Google Drive. However, Everalbum's web portal allows for good photo editing and manipulation, and the app also draws from your Google, Facebook, Dropbox and Instagram accounts. A fine choice if you're happy to have web-friendly (rather than print-worthy) pics on hand. Paul Taylor



3.35GB

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Free Space Now

Windows Store » WIN PHONE 8

Todoist

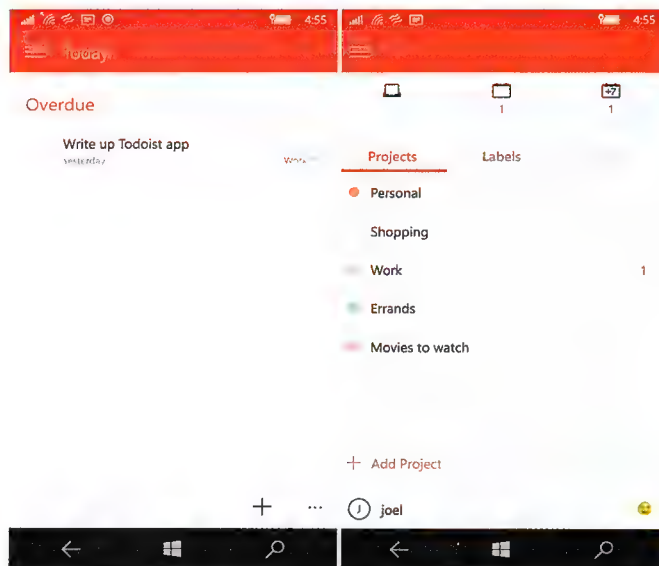
Time to boost your to-do list productivity.

FREE; PREMIUM SUBSCRIPTION, US\$28.99 PER YEAR | TODOIST.COM



Todoist has been around since 2007 and it's managed to make a name for itself as a noteworthy note-taking application on Android and iOS, so it's a welcome addition to the Windows 10 for Mobile platform.

This to-do list service distinguishes itself by providing a streamlined, collaborative productivity app that also has the added ability of actually tracking how productive you've been. Taking the category approach, Todoist allows you to compartmentalise tasks, sub-categorise multi-faceted projects and even group whole classes of items. Because it's cloud based, you can sync it across all your devices and quickly use your phone to pick up where you left off on your laptop. The premium subscription-based tier offers a number of useful additions if you decide you want more that's in the free app, adding the ability to attach PDF documents and other files to notes, get mobile and email reminders for time-sensitive notes, build project templates for regular tasks, get location alerts and track your productivity by keeping a record of the tasks you complete on time. **Joel Burgess**



8Zip Surface Edition

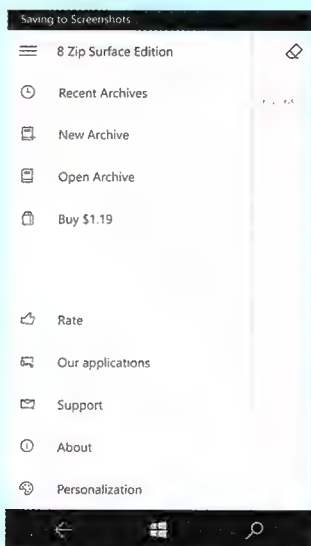
~\$1.20 | FINEBITS.COM



If you're someone who's frequently pushing your smartphone's files to the cloud or enthusiastic about maintaining space on your device, a file zipper might be exactly what you need. 8 Zip

Surface Edition is one of the first truly universal Windows 10 apps that we've seen, running identically across all Windows 10 devices. We found the app to be one of the most feature-rich archiving apps available. It packages ZIP, 7z, TAR, GZIP, BZIP2 and XZ files. Creating a new archive and opening

existing archives is reasonably simple and 8 Zip features the added bonus of customised themes for those who'll be using the interface a lot. The compression process is streamlined, beginning with the creation of a new catalogue folder that houses files of a specific file type of your choice, then from here, you're free to pick and choose the files you want to copy and compress to the archive. This is an excellent one-stop-shop for compressing files, whether that's on your phone or PC. **Joel Burgess**



Transcoder

\$1.19 | TINYURL.COM/APC428-TRANS



Transcoding is something that's generally done on your PC before copying a movie or audio file onto your phone, but if you happen to have a device running Windows 10 for Mobile then you can actually make use of its newer CPU to transcode video and audio on the fly. Transcoder's functions aren't particularly different to what you get on PC; it'll take .MOV, .MP4, .WMV or .AVI files and transcode them into either .MP4, .WMV or .AVI file types. Other than selecting the format you

want, you can also opt for your preference of quality or performance by selecting the algorithm's bias, before finally choosing the destination for your transcoded media file. Most people will use Transcoder to change the file type of movies, but there's also full compatibility with music-file reading and writing across .MP3, .M4A, .WAV, .WMA and even .FLAC. If you can't afford to fork out for an automatic transcoding app-server like Plex, this \$1.19 app is a serviceable (albeit manual) alternative. **Joel Burgess**



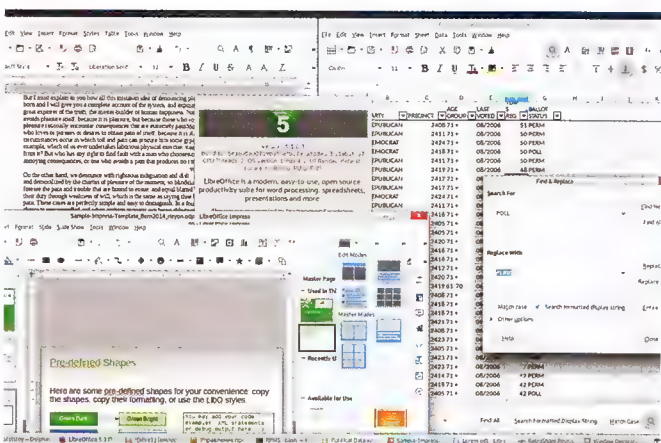


Linux SOFTWARE

LibreOffice

Concentrate with this office suite.

FREE | WWW.LIBREOFFICE.ORG



Since being released, we've noticed that more and more printed announcements, price tags and other quick printouts are typed with Liberation Serif, the default font in LibreOffice. Although anecdotal evidence of popularity, it does suggest the growing adoption of this feature-rich office suite by people who were previously used to the classic word processor interface and wouldn't have appreciated unneeded changes in Microsoft Word.

In contrast, LibreOffice Writer keeps on adopting minor improvements and optimisations. In version 5.1, Writer can now hide a page's whitespace to help you focus on your content (this is a new item in the View menu); it has also enabled by default widow/orphan paragraph text-flow for new documents; and spelling dialog no longer closes after spellcheck completes. Prior to this update, Writer has also had a huge number of other improvements, particularly much better RTF/DOC and ODT handling, better text highlighting and a cleaner toolbar layout. Of course, Writer isn't the only application in the LibreOffice family. Support for XSLX spreadsheets in Calc is getting more mature with each new release, and Calc now imports and exports Microsoft Excel documents more reliably and retains original formatting better.

Impress, the presentation software, now has extra toolbox icons: one for toggling tab bar visibility and another for selecting the working mode. Slide transitions in Impress are now rendered with OpenGL 2.1+ and four extra transition effects have been added. Of course, the LibreOffice 5.1 changelog is vast and it would have taken pages and pages just to list recently added goodies and fixed bugs.

LibreOffice comes pre-installed with most Linux distributions (distros), so you will likely receive the new version together with any system updates. However, you can download many pre-packaged RPM or Deb files for both 32- and 64-bit architectures from the official LibreOffice download page and, separately, help and localisation files for your language, too. **Alexander Tolstoy**

MComix

FREE | BIT.LY/MCOMIX

MComix is a user-friendly, customisable image viewer based on Python and GTK. It's designed to handle comic books (both Western and Manga) and supports a variety of formats. It has a fullscreen and double-page mode, and fits images to a window width, height or both. MComix also supports smart-scrolling for easier reading (just hit the spacebar a few times to try it out) and a special Manga mode (for right-to-left comic books) and can also bookmark pages and add books to the library.

The interface is similar to many document viewers in Linux. The left part of the window stores a vertical page switcher with thumbnails. The top bar has buttons for navigating and adjusting/fitting the page size. Normally, MComix will only show one image at a time. For reading comics, especially on widescreen displays, it would be more convenient to display two images at once next to each other. This way, the reading experience becomes more natural and double-page spreads can be viewed without having to edit the image files.

Alexander Tolstoy



CellWriter

FREE | RISUJIN.ORG/CELLWRITER

Hand-writing recognition hadn't been implemented in Linux until CellWriter came out. This is a grid-entry natural handwriting input panel where you write characters into cells, and the application attempts to recognise your writing at the character level. After launching CellWriter for the first time, you'll enter training mode with a default Latin character table. Here, you're asked to draw each character the way you would normally write it, but without releasing your mouse/pen or a finger.

Training CellWriter to know all letters, figures and punctuation marks takes time, but you only need to do it once. The CellWriter window always stays on top, but allows other windows to take focus. In this way, for instance, you can input hand-written text into LibreOffice Writer or any other application. There are many things you can do with CellWriter, such as train it to know your secret hand-writing code. Generally, we found the recognition algorithm worked pretty instantly and showed very good results, regardless of our ugly handwriting. **Alexander Tolstoy**

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A PC FOR YOUR TV

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ULTIMATE MEDIA HUB!**



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CONTROL A WINDOWS PC WITH A GAMEPAD

Ditch your keyboard and mouse, and your remote, too — control your PC with a gamepad.



TV-ready PCs put to the test

Lindsay Handmer compares stick PCs, NUC-style mini boxes and lounge-room-friendly pre-built systems.

While any old PC can be turned into a home theatre machine, there are loads of compact yet affordable alternatives. They range from simple dongle-sized mini-computers on a stick, to hard-core (but compact) HTPCs capable of high-end gaming.

The 'stick' PCs are typically low-end hardware on a tiny device that can plug directly into an HDMI port. They are ready to go and run Windows 10, and make excellent but basic HTPCs. They lack features like LAN or SSDs, and skip extra outputs such as USB and audio.

NUC-style systems are a step up, with multiple video outputs, separate audio, Gigabit LAN, loads of USB ports and room for a 2.5-inch HDD. They

range from fairly low-end hardware (with Windows included), up to barebones systems with powerful Intel Core CPUs. Some NUCs have Intel IRIS graphics, but are generally not gaming focused.

Mini-PCs range from very compact devices, up to chunkier (but still slim) computers with all the bells and whistles. A major focus of the computers is gaming, with discrete graphics cards and faster CPUs.

While most of the PCs reviewed run Windows 10, with the demise of Media Center, third-party player options are needed. Most also run on OSX, Linux and even iOS or Android, and are ideal upgrades for your HTPC.

Our favourite simple (and free) options are Kodi (www.kodi.tv) and Plex (www.plex.tv) – both of which

can turn any PC into a very powerful HTPC.

HOW WE TESTED

All but one PC (the ARM based CuBox) were benchmarked under Windows 10 (including the Mac Mini). Geekbench 3 was used to provide a cross-platform reference. Barebones systems were tested with 8GB of Kingston RAM and a Samsung 512GB SSD. Games were run on the high setting, at 1080p.

NUC-STYLE
MINI BOXES



\$299 | WWW.LEADERSYSTEMS.COM.AU

BreezeLite SN2-IR

A NUC-style PC with a flatter form factor.

Smaller than a NUC, the tiny little BreezeLite PC measures in at 106 x 106mm square, and just 27.5mm thick. It weighs 190 grams and includes a VESA mounting system. Reminiscent of the hardware in many Stick PCs, the SN2 runs Windows 10 and has an Intel Atom Quad Core Z3735 CPU.

The processor is an older 2014 model, using the 22nm process, and consuming up to 2.2W. It can boost from 1.33GHz up to 1.83GHz, and has Intel HD graphics. It's supported by 2GB of DDR3 memory, which is not user upgradeable.

There is also an inbuilt 32GB eMMC SSD, and extra storage expansion is via the microSD card slot or USB. The PC also has built-in 802.11n Wi-Fi as well as Bluetooth 4.0, for network and peripheral connections.

The BreezeLite outputs video via an HDMI port or VGA, and can run dual monitors. It also has Gigabit Ethernet, dual USB 2.0 on

both front and rear, plus 3.5mm headphone and mic jacks. Sadly, it has no USB 3.0, which limits the speed of external drives. On the front is the SN2 infrared receiver port, which is super handy for HTPC setups.

Despite the slightly dated spec, the BreezeLite machine has more than enough grunt for media playback and running other Windows software. It's fanless and totally silent too. Compared to a Stick PC, the SN2-IR has plenty of extra functionality (such as VGA, IR and more USB ports) that justify the extra cost, without getting into NUC territory.

Verdict

An interesting twist on the mini-PC format with some handy extra features.



\$759 | WWW.GIGABYTE.COM

Gigabyte Brix S

Compact yet powerful.

If you like the NUC style form factor, but want more options, it doesn't get much better than the Gigabyte Brix. While there are options with lower spec CPUs, the GB-BSi7H-6500 tested has a higher-end Intel Core i7-6500U. The dual-core (but four threaded) CPU boosts from 2.5GHz up to 3.1GHz, and has a 15W power envelope. Sadly, the CPU includes the lesser Intel HD 520 graphics (compared to the IRIS 540) – but for those who needs GPU grunt, the Brix line-up includes gaming models with discrete GPUs. On the plus side, it's still able to output 4K resolutions.

The Brix can handle up to 16GB of 2,133MHz DDR3 across two slots. Storage is either via a 2280 M.2 SSD, and/or a standard 2.5-inch SATAIII drive. Getting up and running is as simple as unscrewing the bottom of the Brix, adding RAM and SSD, then installing your preferred OS.

Not surprisingly, the system is quite powerful and will happily run just about any application, as well as play back 4K video. It's also quiet enough to be inaudible across a room.

The unit includes Gigabit LAN, with inbuilt 802.11ac WiFi as well as Bluetooth. The rear panel has dual USB 3.0, HDMI 1.4a and Mini DisplayPort. Round the front, it has another two USB 3.0 connections, as well as 3.5mm headphone and mic plugs.

The Brix includes a VESA mounting plate, and measures in at 46.8 x 112.6 x 119.4 mm.

Verdict

A very compact yet powerful all-round mini-PC perfect for higher-end living room use.





\$260 | WWW.INTEL.COM

Intel NUC5PPYH kit

Also available as a ready-to-go system.

Unlike the higher-end Core series NUCs, the 5PPYH has a super-efficient Braswell Pentium N3700. The quad-core CPU buzzes along at up to 2.4GHz, has a 6W TDP and incorporates Intel HD graphics. A step up compared to the Atom processors found in Stick PCs, the N3700 has more than enough grunt for day-to-day tasks. The compact little PC takes a maximum of 8GB of DDR3 RAM across two slots. It also has room for a 2.5-inch HDD inside, making it easy to fit in loads of extra storage.

For network connectivity, the NUC has Gigabit Ethernet, as well as 802.11ac Wi-Fi and Bluetooth 4.0. The little PC has both an HDMI and VGA port on the back and can drive two monitors (with up to 4K resolutions), or beam video remotely via WiDi. It's got four USB 3.0 ports (split two front and

back), 3.5mm audio I/O jack, plus optical audio output. The NUC also has an SD card reader on the side, and one of the front USB ports handles power off charging.

Importantly for HTPC use, the computer has an IR receiver, so can be controlled directly from a standard remote. The HDMI port also handles eight-channel audio, for surround sound playback. The NUC is quite compact (and VESA mountable), measuring in at 115 x 111 x 51.6mm.

For around \$100 more, the 5PGYH variant comes with 2GB of RAM, a 32GB eMMC SSD and Windows 10 pre-installed.

Verdict

A lower-end yet very versatile and useful HTPC option.



\$625 | WWW.INTEL.COM

Intel NUC6i5SYH kit

Build your own HTPC.

One of the most versatile mini-PCs out there, the Intel NUC comes in a range of configurations. In this case, a middle-of-the-range barebones system, that ships without RAM or SSD – though some retailers bundle these in.

At the core of the NUC is a 6th Gen Intel Core i5-6260U processor – a dual-core model that runs from 1.9GHz up to 2.8GHz in Turbo, and has a 15W TDP. It also features Iris 540 graphics, which can output to a full size HDMI 1.4b connection, or Mini DisplayPort. You can add in up to 32GB of 2,133MHz DDR4 across dual channels. The NUC can also take a SATAIII 2.5-inch SSD, but also a M.2 SSD of either 22 x 42 or 22 x 80. Installation is quite easy – just unscrew and open the NUC, and slot everything into place.

The Core i5 is a low-power U model, but nonetheless has pretty

decent performance and is ideal for HTPC duties. The Iris graphics are also not too bad, and can handle some casual gaming.

The NUC has built-in 802.11ac Wi-Fi, Bluetooth 4.1 and Gigabit wired networking. It has a 3.5mm audio I/O jack on the front, but the HDMI and DisplayPort connections can output 7.1 surround sound. The PC has four USB 3.0 ports – two front, two on the rear, and 2x USB 2.0 available via internal header.

The NUC measures in at 115 x 111 x 48mm and can be VESA mounted.

Verdict

A powerful and versatile mini-PC that needs kitting out and setting up.





\$1,999 | WWW.LENOVO.COM

Lenovo ThinkCenter M900 Tiny

High-end power, compact package.

The Tiny range from Lenovo comes in a huge variety of spec, from super low-end CPUs, up to powerful Core i7s, running Windows 10. The M900 variant is available from a Core i3, up to a (as tested) Core i7-6700T. The 14nm CPU is no slouch, boosting four cores up to 3.6GHz. It's also got 16GB of 2,133MHz DDR4 RAM, and integrated Intel HD 530 graphics. Storage is handled by a 512GB 2.5-inch SATAIII SSD.

If that spec doesn't take your fancy, the M900 has a large range of customisation options, such as a super-fast NVMe M.2 SSD. The downside to the customisation is that, by default, there are a lot of extras that you need to pay for. Paying an extra \$5.50 for an HDMI or DisplayPort or \$6 for a stand feels a bit cheap. It will cost at least \$22 for 802.11ac Wi-Fi as well, though at least there are five different cards to

choose from. As expected, performance is quite good (and the Intel graphics capable of some light gaming), but also rather expensive for what you get unless you need the extra grunt.

On the front, the M900 Tiny has 3.5mm audio I/O, as well as two USB 3.0 ports. Round the back, it has (optional) HDMI, VGA and DisplayPort, a 3.5mm headphone jack, Gigabit LAN and four USB 3.0 ports. The mini-PC can be VESA mounted too, and measures in at 179 x 182.9 x 34.5mm.

Verdict

Plenty of customisation options and power, at a price.



\$979 | WWW.TICOMPUTERS.COM.AU

TI Computers VivoMini UN65H-M002M

A complete kitted-out system.

Very slightly bigger than the classic NUC form factor, the VivoMini is also a little sleeker and blends in well with Hi-Fi and other AV gear. Also sold as a barebones system without RAM or HDD, our test model has been outfitted for sale as a ready-to-rock system by TI Computers.

At the heart of the VivoMini is an Intel Core i5-6200U CPU that boosts dual cores (and four threads) up to 2.8GHz. The processor includes Intel HD 520 graphics, and is backed up by a massive 16GB of DDR3 RAM.

For OS and storage, TI Computers has outfitted the Vivo with a 250GB M.2 SSD, as well as a secondary 500GB HDD. It also comes with Windows 10 pre-installed, with no bloatware to be seen.

The VivoMini has more than enough power for HTPC duties, and will run most applications without

a hiccup, as well as output 4K video. Sure, it's still not a high-end number cruncher, or a gaming machine, but it can hold its own in a lounge setting. It's also very quiet, even when under load, and is pretty much inaudible across a room.

For network and peripheral connectivity, the VivoMini has dual-band Intel AC1200 Wi-Fi, plus Bluetooth 4.0 and Gigabit Ethernet.

On the back, it has two USB 3.0 ports, HDMI and a 3.5mm audio I/O jack. Round the side, the tiny PC has another two USB 3.0 ports, plus a mini DisplayPort connection and a card reader.

Verdict

Quiet, small and capable from the word go.



STICK PCS



✓✓✓
apc
RECOMMENDS

\$209 | WWW.SOLID-RUN.COM

CuBox-i4Pro

A tiny PC with a difference.

Not really a stick, but still in the same spirit, the CuBox is a very compact cube, measuring 5cm on a side. Unlike the Windows-loving competition, this tiny computer runs Linux or Android. Rather than an Intel CPU, it has an ARM i.MX6-based system on a chip. The CuBox-i actually comes in a number of CPU specs, ranging from single core up to quads. The i4Pro tested has an ARM Quad Core A9 CPU that runs at up to 1.2GHz, as well as 2GB of RAM. It also has Vivante GC2000 graphics, and can output 1080p video via HDMI spec 1.4.

Setting up the CuBox-i is super easy, as the manufacturer has an installer program available for download, as well as Android, Debian Linux and two different Kodi-based media centres. There are also a range of other operating systems supported by the community.

The OS is installed onto an SD card and then simply plugged in and booted up – there's no built-in storage. Performance is solid and, for Android users, it can run many games.

The CuBox has built in 802.11n Wi-Fi, as well as Bluetooth, Gigabit Ethernet, eSATA and optical S/PDIF audio out. It's also got dual USB ports, but sadly both are 2.0 spec. It does also include an IR receiver (and transmitter), for use with existing or programmable remotes.

For those who don't want to run Windows, the CuBox is a very versatile little machine that can tie into your existing AV setup better than some of the competition.

Verdict

A unique little system that will appeal to Linux and Android tinkerers.



apc
HOT PRODUCT

\$229 | WWW.INTEL.COM

Intel Compute Stick II

A very versatile micro Windows PC.

The second edition of original computer stick, the Intel mini-PC bumps up the processor spec and adds some extra features. For those who want even more grunt, there is also an uprated (but very pricey in Australia) version with a CoreM CPU.

The Compute Stick tested has a quad-core Intel Atom x5-Z8300 CPU, which can boost from 1.44GHz up to 1.84GHz. The processor uses just 2 watts (or less), so doesn't need any fans and is very efficient to run continually. The system also has 200MHz Intel HD Graphics, and 2GB of DDR3 RAM. Storage is handled by a built-in 32GB eMMC, but it can also be expanded with a UHS-1 microSD card. An upgrade over the original Compute Stick, the new model has both a USB 2.0 and 3.0 port, which can handle external drives or other peripherals. It also has 802.11n Wi-Fi and Bluetooth 4.0.

The Compute Stick runs Windows 10, which is well optimised for low-end hardware, and is very snappy and smooth in use. While Atom CPU has a surprising amount of grunt (especially for multithreaded applications), don't expect it to replace a full-size PC. For media playback, surfing the net or running basic programs and games, it excels. The unit measures in at 103.4 x 37.6 x 12.5mm and weighs 54 grams.

For Compute Stick users (or the various rebranded products, plus NUCs), Intel provides a pretty decent iOS and Android app that turns a smartphone or tablet into a wireless keyboard and mouse.

Verdict

A touch more expensive than some of the other branded versions, but well worth the cost.





\$214 | WWW.LEADERSYSTEMS.COM.AU

Leader PC on a Stick 2

An instant HTPC.

After Intel launched the Compute Stick, many manufacturers brought out their own versions – some which are essentially identical. That's not a bad thing either, as long as the price is right.

The Leader PC on a Stick has the same underlying hardware as the Intel version, and comes in both the original and new model. While the older Stick uses a Baytrail Atom CPU, the updated version has a newer Cherry Trail quad-core x5-Z8300 CPU, which can hit 1.84GHz. It also has 2GB of DDR3 RAM and 32GB of flash-based storage. For those who want to expand, the PC has a microSD card slot. You can also plug in external drives via the USB 3.0 port, as well as other peripherals such as a keyboard, mouse or gamepad.

The Stick PC hooks into your network with dual

band 802.11n Wi-Fi that has the bandwidth to stream HD video. It also has Bluetooth 4.0, for connecting directly to other devices. It plugs directly into an HDMI socket and comes with a short extension cable.

The unit runs Windows 10 and performance is quite good. While it's no desktop, it has enough grunt for day-to-day tasks and media playback.

The Leader stick PC is powered via microUSB, and includes a 240V adaptor. It is 2A, though, and will not run directly from the USB port on some TVs.

The little PC measures in at 100 x 38 x 12.75mm and weighs just 58 grams.

Verdict

A powerful yet fairly affordable micro PC with loads of uses.



\$199 | WWW.LENOVO.COM

Lenovo IdeaCenter Stick 300

A portable PC begging for an HDMI port.

Available for sale from your local JB Hi-Fi, the Lenovo Stick PC quickly and easily turns any display with an HDMI input into a HTPC. The little computer runs a full proper copy of Windows 10 and can install all your favourite apps. At its heart is an efficient (if somewhat last-gen) Intel Atom Z3735F CPU, that has quad cores buzzing along at 1.33GHz, and boosting to 1.83GHz. It also has 2GB of 1,333MHz DDR3 RAM, and inbuilt Intel HD graphics. Storage is handled by a 32GB eMMC SSD, with extra space available via microSD card.

Getting the system up and running is easy – plug it into a spare HDMI port, connect the microUSB plug and press the power button.

The PC can handle keyboards and mice via its single USB socket, or connect to Bluetooth peripherals.

Once the device is booted up, you can then use the

802.11n Wi-Fi to connect to your network.

The Stick 300 has the performance of a low-end laptop – in other words, capable, but it won't exactly stand out. Windows 10 is well optimised for the hardware, though, and software such as Microsoft Office (plus Windows itself) is snappy and fast.

Of course it won't run demanding applications very well, or play anything but older or casual games, but it handles 1080p streaming just fine.

The unit needs 2A, so won't run from all USB ports, but does come with a short HDMI extension cable. The Stick 300 measures in at 100 x 38 x 15mm.

Verdict

An easy HTPC upgrade for your otherwise dumb TV.





\$199 | WWW.PENDO.COM.AU

Pendo Mini Stick PC

Make your own smart TV on a budget.

Rapidly becoming more prominent, the Pendo brand covers a range of products, from phones to TVs. They are sold through retailers such as JB Hi-Fi, Officeworks and Coles, or online through their own website.

The Pendo Mini Stick PC sticks with the known formula, running Windows 10. It uses an older but still powerful quad-core Intel Atom Z3735 CPU, which can burst up to 1.83GHz. The device has 2GB of RAM built in, and 32GB of flash storage. It also has an SD card reader, which can be used to add another 128GB. Connectivity is via 802.11n Wi-Fi, Bluetooth or USB.

Using the Pendo is as simple as plugging it into a spare HDMI port on your TV (or a monitor) and connecting the included 5V USB power adapter. It boots up like

normal, but you will need a USB keyboard and mouse to get it set up. From there you can connect to a Wi-Fi network, or configure Bluetooth devices.

The Pendo runs a full version of Windows 10, and all your favourite applications can be installed and run. Performance is low-end, but it will happily play back media, run Kodi or Plex and surf the net. The Stick PC is also great for taking on the go - it can be used to instantly turn any screen (such as that older hotel TV) with an HDMI port into a computer.

The Pendo Stick PC measures in at 99.6 x 37.6 x 9.6mm long, and weighs 46 grams.

Verdict

A solid but affordable stick PC



COMPACT
LOUNGE ROOM PCS



\$1,299 | WWW.DELL.COM

Alienware Alpha

A simplified lounge-room PC.

A compact gaming option designed for the living room, the Alienware Alpha comes in a range of specs. While CPUs range from an Intel Core i3 and up, the videocard in all models is a now somewhat behind the times (but overclocked) NVIDIA GeForce GTX 860. It is worth noting that, for 720p or 1080p TV gaming on medium to high details, this is enough, but an option for an upgrade would have been nice.

The Alpha tested has the high-end Intel Core i7-4785T - a quad core that hits 3GHz, unless you need the grunt, for gaming, dropping back to the still capable i5 (or even i3) is worth the substantial cash saving. The Alpha also has 8GB of 1,600MHz DDR3 RAM and a 1TB HDD - no SSD option is available.

Rather than a keyboard and mouse, the Alpha

ships with an Xbox controller. The system runs Windows 10, but also has the Alienware Hivemind interface, which is a simplified option for launching games or playing media.

Network connectivity on the Alpha is handled by Intel dual-band 802.11ac 2x2 Wi-Fi (plus Bluetooth 4.0) as well as Gigabit LAN. On the front, it has dual USB 2.0 ports, plus two more USB 3.0 connections round back. It also has both HDMI outputs and inputs, plus optical audio.

The Alpha is quite compact (partly thanks to a large external power brick) - measuring in at 203 x 203 x 76mm and weighing 2kg.

Verdict

An easy-to-use, ready-to-go gaming system that lacks a little performance for the price.





\$1,899 | WWW.DELL.COM

Alienware X51

Alienware's bigger, more-powerful lounge-room gaming option.

With high-end grunt available in a svelte package, the Alienware X51 is a step up from most mini-PCs. While tiny for a tower, it's still a decent size compared to a NUC, at 343 x 318 x 95mm. The extra space allows the PC to squeeze in a higher-end CPU and cooling, as well as a discrete graphics card, but remain slim enough to hide amongst your other AV gear.

The X51 comes in a large range of specs, from a more affordable Core i5, up to an overclocked Core i7. As tested, our X51 has an Intel Core i7-6700 that boosts to the stock 4GHz. Graphics grunt is provided by the somewhat disappointing AMD Radeon R9 370, albeit with an impressive 4GB of RAM. The GPU can be bumped up to a NVIDIA GTX 960 or 970 for \$204 or \$684, respectively. The X51 also has 16GB of

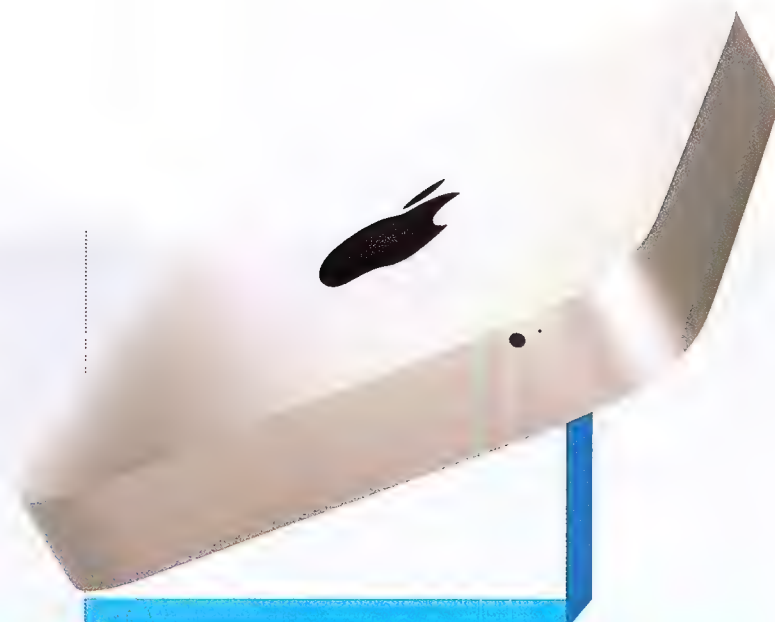
DDR4 RAM, with no option to upgrade or downgrade. Storage is handled by both a 256GB PCIe SSD, and a secondary 2TB 7200RPM SATAIII mechanical drive.

The X51 has performance to spare for your media needs, but will struggle with gaming on that new 4K TV you just bought. Opting for the GTX 970 will help, if you can swallow the cost.

Round the back, the X51 has 802.11ac Wi-Fi, HDMI, Gigabit Ethernet, 4x USB 3.0 and 3x 3.5mm audio I/O. The front panel has another two of both USB ports and 3.5mm headset jacks. The computer also has a rather giant laptop-style power brick.

Verdict

Flashy living room gaming, but mediocre GPU performance for the price.



\$1,099 | WWW.APPLE.COM

Apple Mac mini

Does your HTPC deserve a different OS?

In lounge rooms dominated by Windows (and to a lesser extent Linux), the Mac mini is your only OS X option without building a hackintosh. For many who are invested in the Apple ecosystem, a Mac-based living room computer makes a lot of sense.

These days, many games (especially via Steam) run on Mac, and major media servers and front-end such as Kodi and Plex have OS X versions. Even then, you can dual boot Windows for the best of both worlds. The base level model is pretty affordable, too, and compares well to a lower-end NUC, with a handy IR receiver built in.

The Mac mini tested is middle of the range, and features an Intel Core i5-4278U CPU that boosts from 2.6GHz up to 3.1GHz. It is an older dual-core CPU from 2014 (though

still powerful), and its likely Apple will announce a refreshed model towards the end of 2016.

The computer also has 8GB of RAM (upgradeable to 16GB), plus either a 1TB HDD or 256GB SSD. The CPU does include Intel IRIS 5100 graphics, which are fairly capable, and can drive two displays. It also has 802.11n Wi-Fi as well as Bluetooth 4.0.

Round the back, the mini has Gigabit Ethernet, HDMI, dual Thunderbolt 2, four USB 3.0 ports, an SD card slot and two 3.5mm audio I/O jacks.

Carved from a chunk of aluminium, the Mac mini has excellent build quality and measures in at 197 x 197 x 36mm.

Verdict

Some great HTPC features, but wait for the coming refresh of dated hardware.





\$1299 | WWW.TICOMPUTERS.COM.AU

TI Computers GR6

Get your game on with this fully-featured little rig.

The ASUS ROG GR6 is a mini PC designed for living room gaming, media playback or taking along to a LAN. It's normally a barebones system, but TI Computers have fully kitted out system that's ready to go - all you need to do is plug it into your TV and start gaming.

The GR6 is built around the Intel Core i5-5200U CPU - an efficient but still pretty powerful dual core (and 4 threaded) processor that boosts up to 2.7GHz. Gaming grunt is provided by a GeForce GTX960M, with 2GB of GDDR5 RAM. The TI Boffins have added 8GB of DDR3, plus a super-fast 250GB SSD. For extra media storage, the computer has a secondary 1TB 7200 RPM HDD.

The Ti GR6 machine is targeted at casual lounge room gaming, and while not high end, it's an affordable and oh so easy way to get your Steam titles up on the TV. Most

games will run just fine at 1080P, albeit with the need to drop back the detail levels on some games. The system also has SupremeFX Audio, with 5.1 channels of excellent media and gaming sound. It has inbuilt 802.11ac Wi-Fi, for lag free gaming without extra cables.

Round the back the GR6 has HDMI, DisplayPort, Gigabit Ethernet, Optical S/PDIF out, 4x USB 3.0, and three 3.5mm audio jacks. On the front you also get headphone and mic I/O connections, plus 2x USB 2.0, with charging.

The whole system is super compact, measuring in at 238mm high, 245mm deep and just 60mm wide.

Verdict

An easy and affordable way to play your Steam games in the lounge room



\$1199 | WWW.TICOMPUTERS.COM.AU

TI Computers Vivo VC65R-G002M

A sleek mini PC with loads of unique drive options.

Bigger than a NUC, but still a very compact little PC, the ASUS VC65R packs a lot of power into a lounge room friendly format. Our model is kitted out by TI Computers (and is ready to go out of the box with Windows 10), but you can also buy it as a barebones system.

The mini PC has a Core i5-6400T buzzing in its heart, which pushed 4 cores up to 2.8GHz, and features Intel HD 530 Graphics. It's been fitted with 8GB of DDR3 RAM by the TI boffins, as well as dual 240GB SSDs running in RAID 0 for extra speed. It also has dual 500GB HDDs in RAID 1, to give extra storage that is fast, yet reduces the chance of losing important data.

While not designed for gaming, the VC65R makes for an excellent high end HTPC, which can handle 4K streams and other tasks such as

transcoding.

For connecting up to your screen of choice, the Vivo has HDMI, DisplayPort and VGA - which can be handy for some older projectors. It also has super-fast dual band Intel AC1200 Wi-Fi (plus Bluetooth 4.0), and a Gigabit LAN port.

One nice feature with the Vivo is that the PSU is built in, so no extra power brick is needed.

Round the back is has four USB 3.0 ports (plus another two up front that handle quick charging), a legacy COM port, dual 3.5 audio I/O jacks and a card reader on the side.

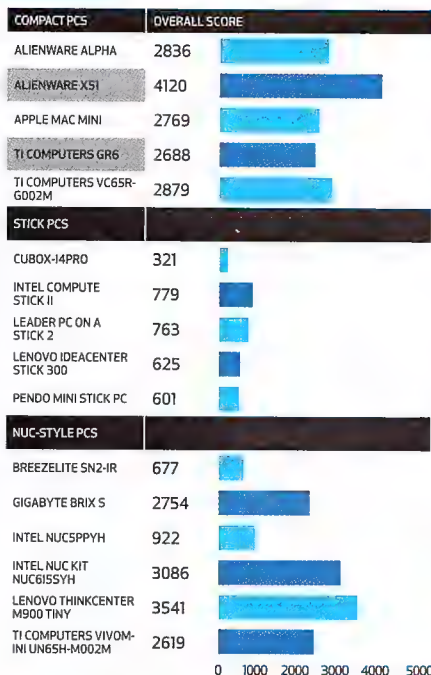
Verdict

A solid workhorse machine with loads of HTPC potential

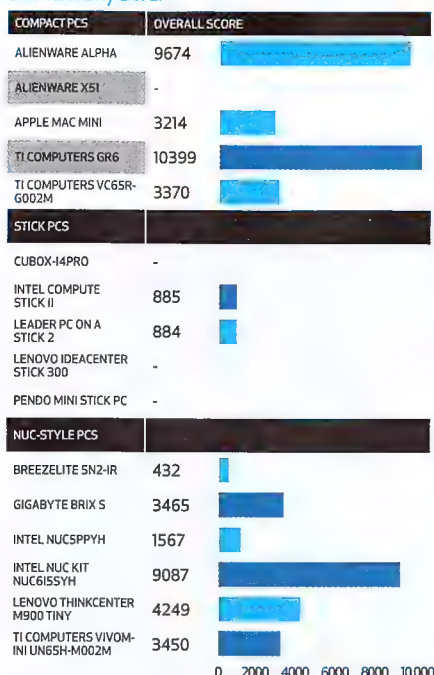


LABS BENCHMARK RESULTS

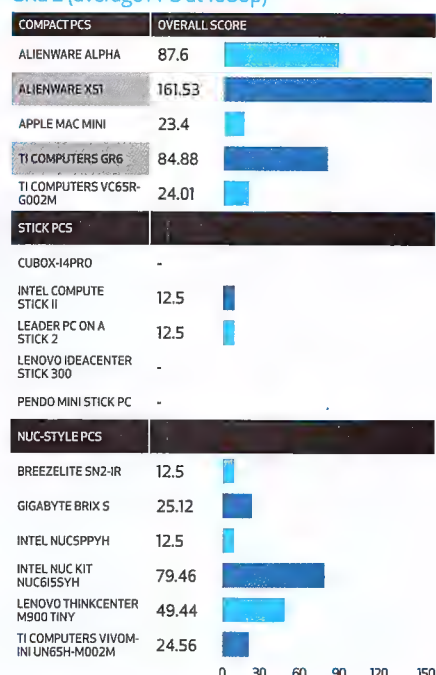
GeekBench 3



3DMark Sky Diver



Grid 2 (average FPS at 1080p)



SPECS

LOUNGE ROOM MINI PCS

ALIENWARE ALPHA	INTEL CORE I7-4785T	GEFORCE GTX 860	8GB 1600MHZ DDR3	1TB HDD	802.11AC WIFI, GIGABIT LAN	HDMI	2X USB 3.0, 2X USB 3.0	203 X 203 X 76MM
ALIENWARE X51	INTEL CORE I7-6700	RADEON R9 370 4GB	4GB DDR4 RAM	256GB SSD, 2TB HDD	802.11AC WIFI, GIGABIT LAN	HDMI	4X USB 3.0	343 X 318 X 95MM
APPLE MAC MINI	INTEL CORE I5-4278U	INTEL IRIS 5100	8GB DDR3	1TB HDD	802.11N WIFI, GIGABIT LAN	HDMI, THUNDERBOLT 2	4X USB 3.0	197 X 197 X 36MM
TI COMPUTERS GR6	INTEL CORE I5-5200U	GEFORCE GTX 960M	8GB DDR3 RAM	256GB SSD + 1TB HDD	802.11AC WIFI, GIGABIT LAN	HDMI, DISPLAY-PORT	4X USB 3.0	238 X 245 X 60MM
TI COMPUTERS VC65R-G002M	INTEL CORE I5-6400T	INTEL HD 530	8GB DDR3	2X 240GB SSD, 2X 500GB HDD	802.11AC WIFI, GIGABIT LAN	HDMI, DISPLAY-PORT, VGA	6X USB 3.0	196 X 196 X 60MM

STICK PCS

CUBOX-I4PRO	ARM QUAD CORE A9	VIVANTE GC2000	2GB RAM	SD CARD SLOT	802.11N WIFI, GIGABIT LAN	HDMI	2X USB 2.0	50 X 50 X 50MM
INTEL COMPUTE STICK II	INTEL ATOM X5-Z8300	INTEL HD GRAPHICS	2GB DDR3	32GB EMMC SSD	802.11N WI-FI	HDMI	1X USB 2.0, 1X USB 3.0	103.4 X 37.6 X 12.5MM
LEADER PC ON A STICK 2	INTEL ATOM X5-Z8300	INTEL HD GRAPHICS	2GB DDR3	32GB EMMC SSD	802.11N WI-FI	HDMI	1X USB 3.0	100 X 38 X 12.75MM
LENOVO IDEACENTER STICK 300	INTEL ATOM Z3735F	INTEL HD GRAPHICS	2GB DDR3	32GB EMMC SSD	802.11N WI-FI	HDMI	1X USB 2.0	100 X 38 X 15MM
PENDO MINI STICK PC	INTEL ATOM Z3735	INTEL HD GRAPHICS	2GB DDR3	32GB EMMC SSD	802.11N WI-FI	HDMI	1X USB 2.0	99.6 X 37.6 X 9.6MM

NUC-STYLE PCS

BREEZELITE SN2-IR	INTEL ATOM Z3735	INTEL HD GRAPHICS	2GB DDR3	32GB EMMC SSD	802.11N WI-FI	HDMI, VGA	4X USB 2.0	106 X 106 X 27.5MM
GIGABYTE BRX S	INTEL CORE I7-6500U	INTEL HD 520	UP TO 16GB DDR3	2.5" / M.2 SSD	802.11AC WIFI, GIGABIT LAN	HDMI, MINI DISPLAYPORT	4X USB 3.0	46.8 X 112.6 X 119.4MM
INTEL NUCSPYH	INTEL PENTIUM N3700	INTEL HD GRAPHICS	UP TO 8GB DDR3	2.5" HDD	802.11AC WIFI, GIGABIT LAN	HDMI, VGA	4X USB 3.0	115 X 111 X 51.6MM
INTEL NUC KIT NUC6I5SYH	INTEL CORE I5-6260U	INTEL IRIS 540	UP TO 32GB DDR4	2.5" / M.2 SSD	802.11AC WIFI, GIGABIT LAN	HDMI, DISPLAY-PORT	4X USB 3.0	115 X 111 X 48MM
LENOVO THINKCENTER M900 TINY	INTEL CORE I7 6700T	INTEL HD 530	16GB DDR4 RAM	512GB SSD	802.11AC WIFI, GIGABIT LAN	HDMI, DISPLAY-PORT, VGA	6X USB 3.0	179 X 182.9 X 34.5MM
TI COMPUTERS VIVOMINI UN65H-M002M	INTEL CORE I5-6200U	INTEL HD 520	16GB DDR3	250GB SSD, 500GB HDD	802.11AC WIFI, GIGABIT LAN	HDMI, MINI DISPLAYPORT	4X USB 3.0	131 X 131 X 52MM

DIY lounge-room PC

Give your TV something serious to play with and build your own home cinema computer. Darren Yates looks at how to start on any budget.



OS, but it at least helps get your head and your spending pointing in the same direction. It's always a mistake to think one stellar component will turn a Fiat into a Ferrari – it rarely happens, if ever.

DOWN TO CASES

Once you've decided the main function of the build, the key component choice really is the case, given it dictates everything that will go inside. The key to good case design for TV PCs is clean minimalist looks with good airflow and enough room to make life easy. Super-tiny Micro-ITX cases look cute – until you have to work on them. A case jam-packed with goodies will also likely have poor airflow, raising the temp and fan RPMs. And avoid windowed cases with bright LEDs – unless you love the distraction.

DOES IT FIT?

The other key thing to watch for is ensuring everything you buy actually fits. For example, is the CPU cooler too tall to fit inside the case? Is the PSU too long? Is the graphics card too long? Will the motherboard fit? It's hard to go wrong fitting gear into a tower case,

Building a TV PC sounds like it should be easy – after all, you already have the screen figured out! But it can be anything but. Having a PC in your loungeroom adds two complicating factors – first, it has to be quiet and, second, it has to be as unobtrusive as possible. And that's before you even consider whether you're after a gaming system, something to stream Netflix or Stan, your next movie library server or all three, let alone how much cash is in the kitty, or thinking of movies or gaming at 4K resolution.

SILENCE IS GOLDEN

Going for 'quiet' really does introduce a whole new range of parameters for you to consider. PSU noise, graphics card fan noise, CPU cooler noise, case airflow and noise-dampening, even your choice of PSU fan bearing all impact on just how loud your PC will be. It also impacts on the hip-pocket nerve and, in turn, on how much performance bang you'll get for your buck.

"The key to good case design for TV PCs is clean minimalist looks with good airflow and enough room to make life easy."

ALL ABOUT PERCENTAGES

Having reviewed one or two computers in my time, I've found that simple percentage rules-of-thumb can help get your budget and your component choices in something approaching alignment.

For example, with at least \$1,000 to play with, I aim to roughly split my budget:

- 25–30% max. on graphics card;
- 20% on storage;
- 15% on CPU;
- 10% each on motherboard, PSU and case; and
- 5% on RAM.

As I said, it's a rough guide and doesn't include the cost of a Windows

but mini-ITX cases require research, so watch component dimensions like a hawk – particularly PSU and graphics card length and CPU cooler height. Check those case dimensions carefully for component size limitations.

SYSTEM BUILDS FOR ANY BUDGET

With all that in mind, we've pieced together five different TV PC builds covering budgets from \$500 to \$2,500. We've explained why we've chosen the more controversial components to each build where applicable, but as there's no way we can make everyone happy, use these builds as a jump-off point to your own design. And look out for our option alternatives!

TV PCs for \$500 & \$1,000

TV PC FOR \$500

Let's call a spade a shovel – at this price, you're best off looking at an entry-level Intel NUC system. Mwave (tinyurl.com/jcuy8fo) has Intel's previous-gen BOXNUC5I3RYK Core i3-5010U dual-core NUC kit, bundled with 4GB of DDR3-1600 RAM and 120GB Intel 535 M.2 SSD for \$499. With integrated Intel 802.11ac Wi-Fi networking, it'll make the 120GB SSD seem less small – just drag out that old PC system in the cupboard, turn it into a basic file server, leave it in the study and stream to the NUC box connected to your telly. Or if you're wired, use the NUC's Gigabit Ethernet port instead.

Even so, gaming here will likely be (cough), although the integrated HD Graphics 5500 GPU does have accelerated support for H.264 playback at least to 1080p.

As for 4K playback? Unlikely. For starters, the HD 5500 GPU only offers 'hybrid' H.265 acceleration (via software) and with HDMI 1.4a, 30Hz playback is the end-stop. The DisplayPort connector is rated for 4K@60Hz but we doubt the Core i3-5010U CPU will keep up. Still, for \$500, the options are limited – and that's without costing an OS!

TV PC FOR \$1,000

After \$500, building a \$1,000 TV PC should be dead-easy, but try dragging in 4K support and things get tricky real quick! Watch out for motherboards claiming '4K Ultra HD' capability – most are 24Hz refresh rate only. The problem is genuine 4K@60Hz video for gaming and movies requires either HDMI 2.0 or DisplayPort 1.2, and hope your 4K TV has a matching port.

The cheapest HDMI 2.0-ready graphics card available at the moment is Nvidia's GeForce GTX 950, starting at around \$230. Unfortunately, there are



Intel's 5th-gen Core i3 NUC is your best bet for a quiet \$500 TV PC.



Cougar's QBX case is affordable start to a sub-\$1,000 TV PC.

no low-profile GTX 950 cards, so slim-line HTPC cases like SilverStone's ML04 are out. In the end, we opted for two different system specs for this price-point – one based on the SilverStone ML04 case and another for the stylish Cougar QBX.

The QBX build runs ASUS's GTX 950 STRIX card, which includes HDMI 2.0 for 4K@60Hz playback and has a great rep for low-noise, as does Seasonic's 360-watt G-360 PSU, which meets Nvidia's 350-watt minimum requirement for the GeForce GTX 950 GPU.

By contrast, the ML04 build is a 1080p-only TV PC, but delivers more storage via Intel's 240GB 535 SSD and a 2.5-inch 1TB WD Blue HDD. It can handle a standard (small) ATX PSU, such as the Seasonic G-360, but word is it's a very tight squeeze, so we've gone

for Silverstone's own smaller SFX PSU instead. Both systems run Intel's new dual-core Core i3 6100, which runs cool and quiet, thanks to its low 51-watt thermal design power (TDP) rating.

Still, gaming will be limited, although the QBX build will be the pick of the two in that endeavour.



Want something that doesn't look like a PC? SilverStone's ML04 works.

SUGGESTED TV PC BUILDS					
HIFI COMPONENT UNDER \$1,000			MINI-ITX TOWER UNDER \$1,000		
CPU	INTEL CORE I3 6100 DUAL-CORE CPU	\$170	CPU	INTEL CORE I3 6100 DUAL-CORE CPU	\$170
CPU COOLER	(USE STOCK COOLER)		CPU COOLER	(USE STOCK COOLER)	
MOTHERBOARD	ASROCK H110M-ITX LGA1151	\$125	MOTHERBOARD	ASROCK H110M-ITX LGA1151	\$125
RAM	8GB DDR4 RAM (1 STICK)	\$50	RAM	8GB DDR4 RAM (1 STICK)	\$50
GRAPHICS CARD	(INTEGRATED GPU)		GRAPHICS CARD	ASUS GEFORCE GTX 950 STRIX 2GB	\$255
STORAGE - SSD	240GB INTEL 535 SSD (5-YEAR WARRANTY)	\$180	STORAGE - SSD	N/A	
STORAGE - HDD	1TB WESTERN DIGITAL WD10JPVX 2.5-INCH	\$90	STORAGE - HDD	1TB WESTERN DIGITAL WD10JPVX 2.5-INCH	\$90
CASE	SILVERSTONE ML04	\$105	CASE	COUGAR QBX MINI-ITX	\$80
PSU	SILVERSTONE ST455F 450-WATT SFX	\$110	PSU	SEASONIC G-360 360-WATT	\$90
OPERATING SYSTEM	MICROSOFT WINDOWS 10 HOME 64-BIT DVD	\$149	OPERATING SYSTEM	MICROSOFT WINDOWS 10 HOME 64-BIT DVD	\$149
TOTAL COST		\$979	TOTAL COST		\$1,009

TV PC for \$1,500

With \$1,500 in the kitty, this Mini-ITX 4K@60Hz build covers all the bases, but leans towards gaming and low-noise over storage. Here's how:

CPU COOLER

NOCTUA NH-C14S

This one isn't cheap and or easy to find, but it's one of the quietest and most versatile coolers on the market. The NH-C14S combines very low-noise levels with excellent cooling and vertical airflow. Most motherboards pack in VRMs (voltage regulator modules) around the CPU socket and there's a decent argument that east-west airflow from most common tower coolers doesn't help VRM cooling. With the NH-C14S' north-south airflow, excess air is more likely to reach the VRMs and keep the board happy. You can also choose to have the fan above or below the heatsink fins, changing the cooling dynamics and dropping vertical height from 142mm to 115mm.

Noctua green-lights this cooler for use with the ASRock H170M-ITX/ac motherboard and in either fan configuration, it'll fit the 170mm maximum cooler height of the Fractal Design case.

GRAPHICS CARD

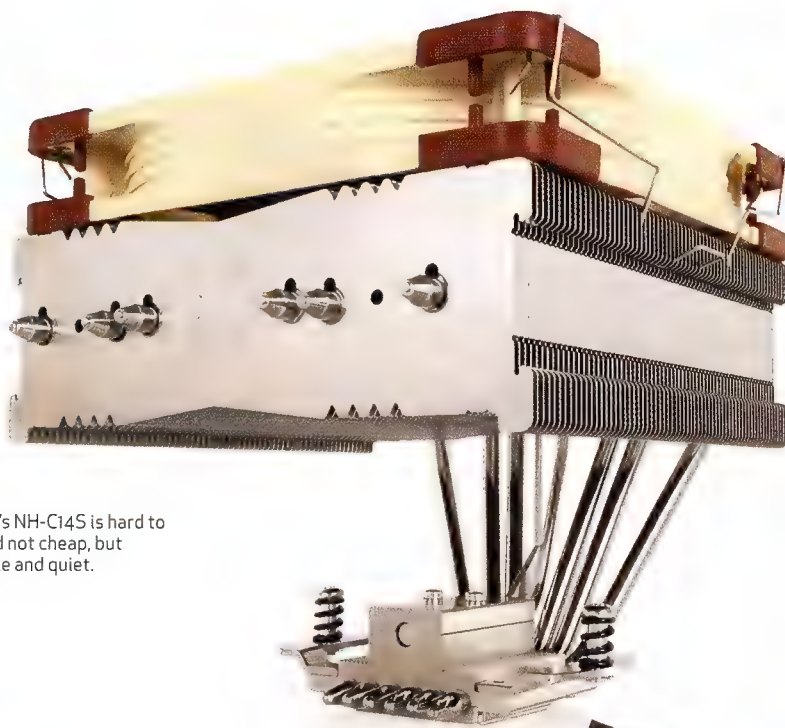
ASUS GEFORCE GTX 960 STRIX 4GB OC

Of that \$1,500, we've put roughly 25% into the graphics card here, which is about as much as you should go if you don't want deep compromises elsewhere. ASUS's STRIX series is known for its quiet running and the GTX 960 is only 220mm long and 120mm high, so it should have no trouble fitting in the Core 500 case.

It'll deliver what you might call 'mainstream' 1080p gaming speed, but more important is the HDMI 2.0 and 4K@60Hz video output for your telly.



Fractal Design's Core 500 handles six drives and CPU coolers to 170mm.



Noctua's NH-C14S is hard to find and not cheap, but versatile and quiet.

PSU

SEASONIC S12II-520 520-WATT

Seasonic PSUs are as tough as nails, but also have a great rep for being surprisingly quiet. The S12II-520 is '80 Plus Bronze'-rated for efficiency and well exceeds Nvidia's 400-watt minimum rating for the GTX 960 GPU. The fluid dynamic fan bearing should also help reduce noise. A good quality PSU always repays and this one includes a five-year warranty. Seasonic's G-450 is better again, but a very tight fit with the GTX 960.

MOTHERBOARD

ASROCK H170M-ITX/AC

This is a new release from ASRock combining Intel's H170 chipset, with 802.11b/g/n/ac Wi-Fi and Bluetooth 4.0 in a Mini-ITX form factor. Right now, it's the cheapest H170 Mini-ITX board you'll find in Australia. There's no overclocking here, so it matches the Core i5 6400 quad-core CPU, but unlike the B150 or H110 alternatives, the H170 still gives you RAID0, 1, 5, 10 options should you expand the storage.

CASE

FRACTAL DESIGN CORE 500 MINI-ITX

Cases are such a personal thing, but we think Fractal Design's Core 500 is a decent option. Pretty much right on \$100 on the street, it's mostly roomy with good airflow to help with passive cooling and keeping the system quiet. The GTX 960 card and S12II-520 PSU should have no trouble fitting together



ASUS's GTX 960 STRIX is better suited to 4K movies than 4K gaming

and the case handles up to six 2.5-inch drives.

STORAGE

250GB SAMSUNG 850 EVO SSD

By going for the Noctua NH-C14S and GTX 960, we've had to cut back storage and Samsung's 250GB 850 EVO is about as affordable as it gets. It uses triple-level cell (TLC) NAND flash, which isn't everyone's cuppa, in which case, Crucial's 250GB MX200 or Intel's 240GB 535, both with 16-nanometre MLC NAND flash at around \$170, are budget-happy alternatives.

TV PC for \$2,500

Even at \$2,500, there's a premium to pay for combining 'quiet' and 'performance' in the same box, but this TV PC should give plenty of room to grow.

MOTHERBOARD

ASUS Z170-AR

At this price, we're aiming for as much of everything as we can get — performance, storage, gaming, low-noise — plus a little redundancy for good measure. ASUS's Z170-AR is one of the cheapest Z170-chipset boards at around \$240, but also has Nvidia SLI support. Plus, it'll overclock the unlocked Core i5 6600K CPU, has six SATA3 ports and will RAID0, 1, 5 or 10 your storage.

NOTE: The Noctua NH-C14S cooler is rated for up to 140 watts TDP, enough to support 'medium'-level overclocking on the 91W TDP'd Core i5 6600K CPU (noctua.at/en/tdp-guide).

STORAGE

480GB SANDISK EXTREME PRO SSD, 3TB WESTERN DIGITAL WD30EZRZ BLUE HDD

An SSD/HDD storage combo is a common option, giving you a cache of high-speed system storage, plus low-cost bulk storage for your movie/game library. We've gone for the top drawer on the SSD with SanDisk's 480GB Extreme Pro. This thing is nice and quick and comes with a market-leading 10-year warranty. Western Digital's 3TB Blue drive isn't super-quick, but it's bulk-storage at an easy price.

GRAPHICS CARD

ASUS GEFORCE GTX 980 STRIX 4GB OC

You have lots of choices here — go for a GTX 970 now for \$500, add a second one later; or go a GTX 980 now for \$750 and add a second later. ASUS's STRIX

series is reportedly as quiet as they come, so it's our choice. One GTX 970 GPU will struggle on 4K gaming; one GTX 980 will be adequate rather than brilliant. Two GTX 970s in SLI do nicely at 4K but go over budget by \$250. Two GTX 980s in SLI rock but flog the budget by \$500, plus the cost of an 850-watt PSU to be safe. On the flip-side, two of anything will be noisier than one.

On the basis of noise level and budget, we've gone for the GTX 980. The choice is yours.

Another alternative? Replace both drives with Samsung's 250GB 850 EVO SSD and WD's 1TB WD10EZEX Blue drive, drop the GTX 980 and go for two GTX 970 cards. Not especially quiet, but it'll give decent 4K gaming for \$2,500.

PSU

SEASONIC G-750 750-WATT

Seasonic's '80 Plus Gold'-rated G-750 delivers excellent performance with low-noise and comes with a five-year



ASUS' Z170-AR offers overclocking plus Nvidia and AMD multi-card gaming

warranty. For a single GTX 980 card build, the \$30-cheaper 550-watt G-550 would also work, but the G-750 includes six PCI-E 6/8-pin power connectors and enough grunt to handle two reference GTX 980 cards or two GTX 970 STRIX OC cards in SLI mode (two GTX 980 STRIX OC cards would likely near the G-750's limits). The 850-watt M12 II EVO is almost as good and only costs \$20 more.

CASE

FRACTAL DESIGN DEFINE R5

We're not worrying about 'small' with this build, but Fractal Design's minimalist Define R5 case will ensure it doesn't draw attention to itself. It's packed with room for up to eight drives, still appears to manage good airflow, yet features solid noise-dampening mats on major panels, even removable dust filters.



Fractal Design's minimalist Define R5 is one of the quietest cases going.



One ASUS GTX 980 STRIX is good, two is better if your wallet goes deep.

SUGGESTED TV PC BUILDS

UNDER \$1,500

CPU	INTEL CORE I5 6400 QUAD-CORE	\$270
CPU COOLER	NOCTUA NH-C14S TOP-FLOW	\$120
MOTHERBOARD	ASROCK HI70M-ITX/AC MINI-ITX	\$185
RAM	8GB G.SKILL DDR4-2400 RAM (1 STICK)	\$50
GRAPHICS CARD	ASUS GEFORCE GTX 960 STRIX 4GB OC	\$340
STORAGE - SSD	250GB SAMSUNG 850 EVO	\$130
STORAGE - HDD	N/A	
CASE	FRACTAL DESIGN CORE 500 MINI-ITX	\$100
PSU	SEASONIC S12II-520 520-WATT	\$120
OPERATING SYSTEM	MICROSOFT WINDOWS 10 HOME 64-BIT DVD	\$149
TOTAL COST		\$1,464

UNDER \$2,500

CPU	INTEL CORE I5 6600K UNLOCKED QUAD-CORE	\$350
CPU COOLER	NOCTUA NH-C14S TOP-FLOW	\$120
MOTHERBOARD	ASUS Z170-AR Z170-CHIPSET	\$240
RAM	8GB G.SKILL DDR4-2400 RAM (1 STICK)	\$50
GRAPHICS CARD	ASUS GEFORCE GTX 980 STRIX 4GB OC	\$750
STORAGE - SSD	480GB SANDISK EXTREME PRO	\$330
STORAGE - HDD	3TB WESTERN DIGITAL WD30EZRZ BLUE	\$145
CASE	FRACTAL DESIGN DEFINE R5 MID-TOWER	\$180
PSU	SEASONIC G-750 750-WATT	\$180
OPERATING SYSTEM	MICROSOFT WINDOWS 10 HOME 64-BIT DVD	\$149
TOTAL COST		\$2,494

Choosing a media centre app

Hardware's only half the story to a media PC. Dan Gardiner reveals what you need to consider when picking the best software for your media PC.



Online video streaming services may have taken Australia by storm over the last year, but they can still leave a lot of gaps when it comes to creating the perfect home-media experience. And being a PC mag, we unsurprisingly reckon a media PC is the best way to tie all your disparate media threads together.

We've discussed the hardware and reviewed pre-built PC options elsewhere in this issue, but the other key part of the equation is the software. So which apps should you use to power your home theatre box?

The answer to that question depends on your specific needs. There's host of different approaches you can take, but this guide should help you sort out which one will work best for you. This feature will mostly revolve around our two favourites media apps – Kodi and Plex – but there are many, many alternatives, alongside add-ons and other alternatives made to cover a specific need.

As such, getting set up can be a little involved and will often require you to bolt together two or three different applications and/or install extra plugins to get everything perfect. The good news is that, once done, you shouldn't have to tinker any further; all these apps are pretty much set-and-forget and will even automatically scan and identify new media as it's added.

While Kodi and Plex share similar roots – both are based off Xbox Media Centre (XBMC), a decade-old media player application designed to turn an original Xbox into a device you could play downloaded media on – they do have some key differences. Kodi's a community-built open source app with a heap of add-ons and customisation

options while Plex is a commercial project that's more focused on polish, ease-of-use and streaming to multiple devices. There are reasons to like both, although ultimately we'd suggest settling on one or the other, as much of their functionality does overlap.

At their heart, what both these apps provide is a TV-friendly front-end (also known as a '10-foot user interface' – i.e. one that can be easily used from 10 feet away) for watching movies and TV from the comfort of your couch. That means simplified control schemes with similarly paired-back onscreen elements – at the back end, both Plex and Kodi have what's known as scrapers that will go online and grab information (technical details, synopses, cast and crew credits, alongside images like covers, custom artwork and thumbnails) for all the media you add, making for a slick and clean front-end that's visually appealing and easy to navigate.

KODI: THE FLEXIBLE OPEN-SOURCE OPTION

When we mentioned in our intro that both Plex and Kodi have their roots in XBMC, we're lying. Kodi is actually the new name for XBMC – it officially rebranded back at the end of 2014. Kodi's main strengths are that it's an open-source, all-in-one application that both catalogues your media and plays it back, and it has the strongest community support of any of these media centre apps. It's also deliberately extensible, meaning there's a heap of add-ons that can broaden Kodi's abilities and many of these can be downloaded and installed from directly within the main interface.

There's additional skins that can change the app's look, video plugins

that will let you watch the likes of YouTube, Vimeo and dozens of other services, and while there's no native support for live-TV, it can act as a front-end for external PVR server apps, and a whole lot more besides.

It's one of the few media centre apps that has disc playback built-in – DVDs (as well as DVD ISOs or just a disc's VIDEOS folders) work perfectly including being able to browse menus. Blu-ray support is a little less developed at this point – it works, but only on non-protected discs, which excludes basically anything commercial. You can rig Kodi up so it passes off Blu-ray playback to a third-party app (like Cyberlink's excellent PowerDVD) and then returns to the main Kodi interface when you're done.

The main shortcoming of Kodi is that it's not really designed to be a media server – it can't share your media collection with other devices and the associated mobile apps are generally just remotes made to control your main device. You can grab Kodi for Windows, Mac and Linux at kodi.tv/download.

PLEX: THE MULTI-DEVICE HUB

Plex is a platform that basically consists of two parts: a server app, which indexes and catalogues all your media files, and client 'player' apps that architecture with built-in video-reencoding (AKA transcoding) capabilities that makes it easy to stream (and optionally sync) content to other devices, including Android and iOS smartphones and tablets.

So if you want to watch your videos across multiple devices – something that's more common in our smartphone age – it's the simplest and most straightforward option. And Plex's

Transcoding with Kodi

Can you have the best of both worlds?

If you're keen on Kodi but want Plex-like transcoding capabilities, check out Emby at emby.media. Emby is essentially a more open alternative to Plex — it's an actively maintained and open-source project (which formerly was unimaginatively named 'MediaBrowser') with server and client apps on a wide variety of platforms. It is a commercial program, but it's one that can be more-affordable than Plex: it largely makes its money by selling commercial iOS and Android apps, although like Plex, its also introduced a subscription option that gets you additional features. Now, the key element here is that it's possible to merge Kodi and Emby so that they play nice with

one another — basically, you need to disable all of Kodi's built-in media indexing features and get it to use Emby's database instead. The process to do so is a rather long but relatively straightforward one — we don't have the space to publish a step-by-step guide here, but if the idea appeals, you can head to kodi.wiki/view/Add-on:Emby_for_Kodi for the full rundown.

As an aside, Emby itself has a reasonably impressive front-end that covers all the same basics as Kodi when it comes to playback, so you might even want to leave Kodi out of the equation entirely and just try Emby to begin with.

creators have made a conscious effort to get players onto as many mainstream platforms as possible, meaning there are native apps not just for PC and Mac (and an unofficial client for Linux), but also on the major mobile platforms, media players and even some big-brand TVs.

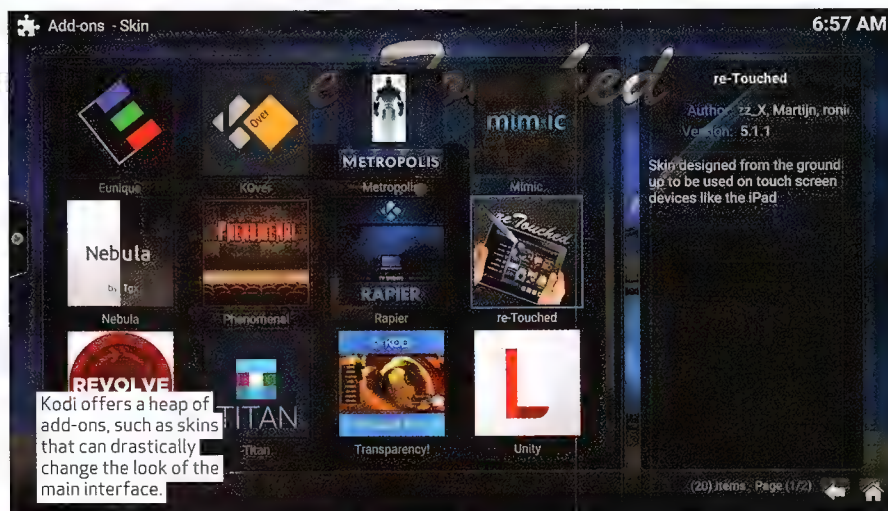
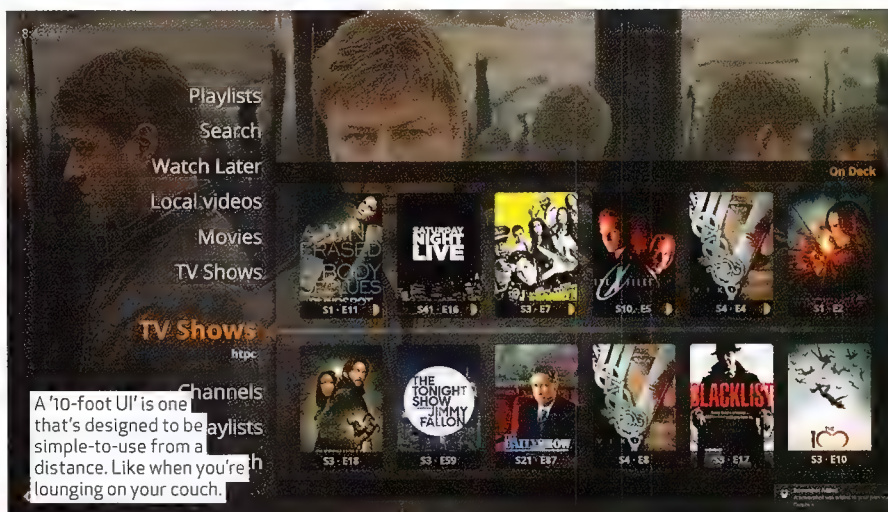
Add-ons for Plex are known as Channels. While there aren't as many available here as there are in Kodi, you can add a lot of functionality to the app such as adding dedicated interfaces for online streaming services like YouTube. (Although sadly, neither Kodi or Plex support Netflix or other commercial services.) Plex has some other fairly neat and unique tricks it can pull, too, like the ability to stream videos straight in your web browser, so you don't even need to have a Plex 'client' player app installed.

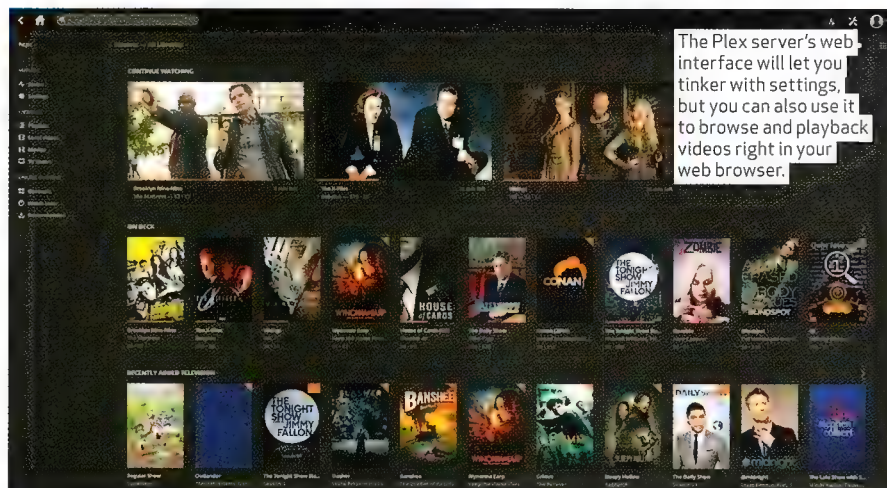
The main caveat with Plex is that it's subscription based; if you want its more advanced features, you'll need to cough up a fee (US\$5 per month or US\$40 per annum), or pay the rather-hefty lifetime subscription price of US\$150. However, you can unlock limited transcoding — although there's no option to sync — by making a one-off purchase in the iOS and Android apps for the equivalent of US\$4.99 (around AU\$7-8).

As we've mentioned above, setting up Plex actually requires installing it in at least two places. You'll need Plex Media Server on the PC that'll serve as the central hub for sharing your media, as well as Plex Home Theatre (or the platform-specific Plex app) on any of your playback devices. You can actually have both these programs running on the same device so it's both the media server and a player, but you will need to set up the server side first. You can find the installers for both server and player at plex.tv/downloads.

GET SET UP FASTER

After you've installed either of the above media centre apps, the next step is to point them at your media files. You can have your TV shows and movies

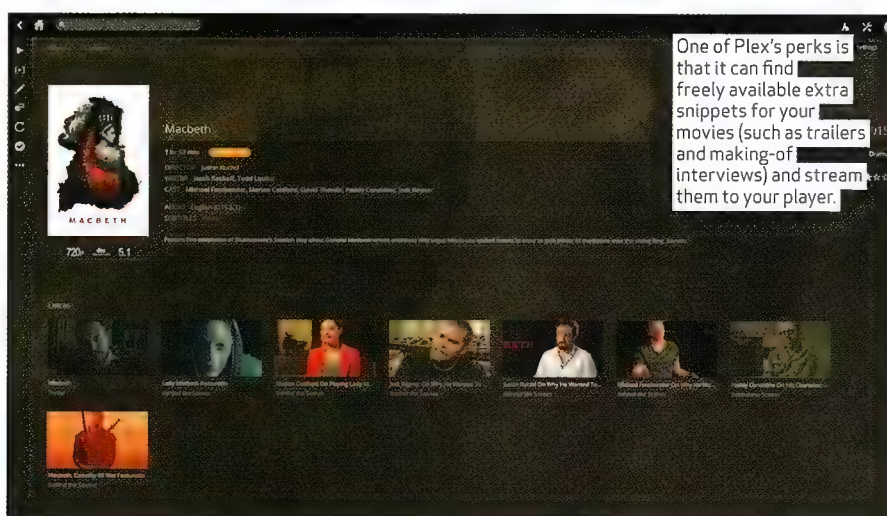




Plex beyond the PC

As we've mentioned in the main story, one of the things we like best about Plex is how many platforms you can get players for. Here's a quick list of where you can find player apps:

- Android
- Android TV (used on the latest Sony and Panasonic televisions)
- Apple TV (4th generation)
- iOS
- PlayStation 3/4
- Select Samsung and LG TVs
- Xbox 360/One



of shows in their own folders (so something like `\Firefly\Season 1\Firefly - 1x01.mkv`), but its not actually required by Plex or Kodi as long as your filenames are in order.

If the latter's sounding like an overly onerous job, there are actually a few software options out there that can sort out identifying and renaming your media collection; if you've got a large one that's not very well organised, then they should be your first port of call before you even think about Kodi or Plex. These are our three favourite options:

- FileBot (available for Windows, Mac and Linux) — sourceforge.net/projects/filebot
- tinyMediaManager (available for Windows, Mac and Linux) — www.tinymediamanager.org
- rebox.NET (available for Windows) — www.videohelp.com/software/rebox.NET

POINTING TO YOUR MEDIA

In Kodi, all the settings are accessed through the main menu, while in Plex, you'll need to get to them via the web interface.

In Kodi, adding videos is done via the main Videos menu item — select it and then click 'Files > Add videos...'. Next, click Browse and navigate to your first TV or movies folder and click 'OK', then click 'Add'. You'll be prompted to select a what type of media is contained in this folder (either TV, movies or music videos) so use the arrow buttons to pick the appropriate type, then click 'OK'. Kodi will then scan the folder's content and download info and images pertaining to what it finds. While that's happening, you can feel free to keep adding more sources until you're satisfied.

The process for Plex is very similar. Immediately after installing the server app, you'll be taken to the web interface (it's usually found at `127.0.0.1:32400`) and the first screen you'll see has a big 'Add library' button;

"Plex and Kodi don't particularly care where your video files are, just what type of media they represent."

stored in multiple folders across multiple locations; they can be on local hard drives, USB storage or shared over the network (from a NAS or other PC). Plex and Kodi don't particularly care where your video files are, just what type of media (i.e. either movies or TV) they represent. We'd strongly recommend having all your movies in one master 'Movies' folder and all your television in one called 'TV' or 'TV shows' or something similar, as this means any new shows or films you add in future will get automatically picked up by Plex and Kodi.

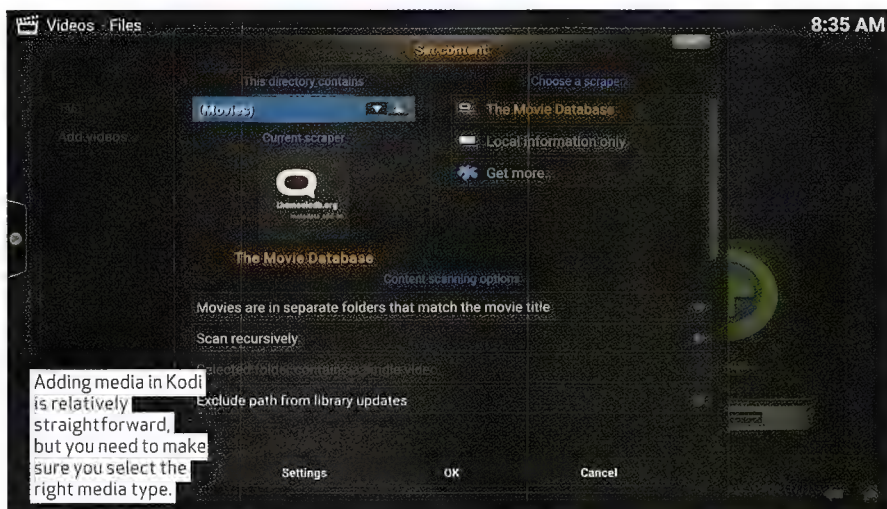
NAMING CONVENTIONS

Kodi and Plex identify your videos based on trying to match their file names against community-built online databases of movies and TV shows, and

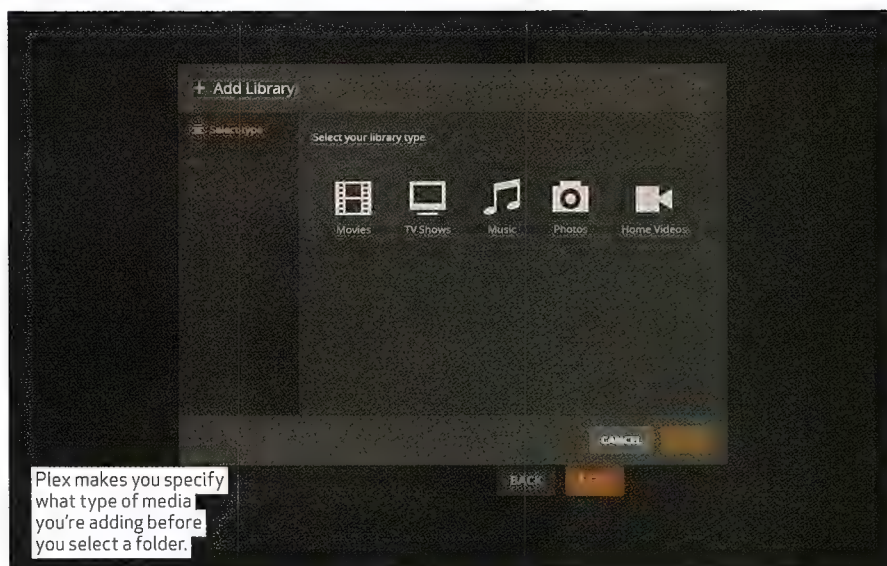
they both follow the same styles when it comes to preferred file names. As such getting your file names in order should be the first thing you do, even before installing your selected media centre app.

For movies, the naming convention is fairly simple: Movie Name (Year) — for example, *Citizen Kane (1941)*. If you have any subtitles, they'll need to match the video file's name too, so for our example flick, you might have two files *Citizen Kane (1941).mkv* and *Citizen Kane (1941).srt*.

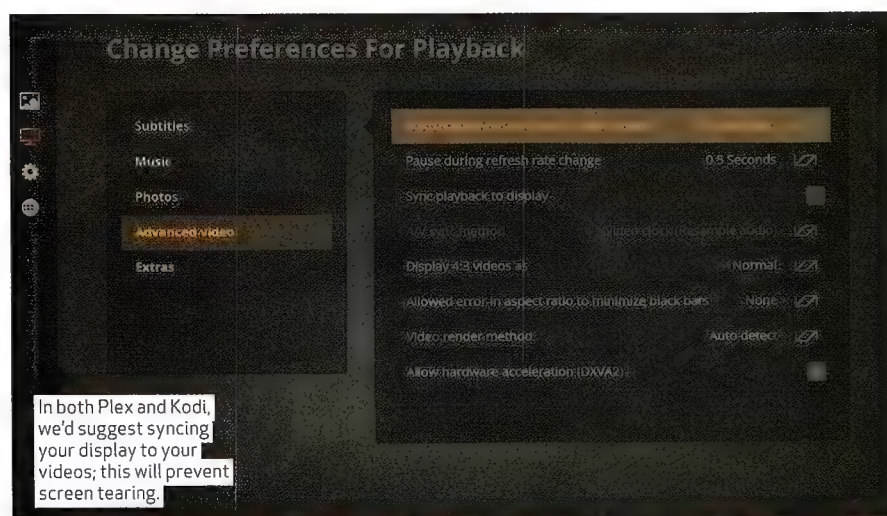
For TV shows, the preferred convention is TV Show Name - 1x01 — so for example, *Firefly - 1x01*. The latter 'episode number' part of the file name is a little flexible — so instead of *1x01* it can also be *s01e01* or just *101*. You may wish to put specific seasons



Adding media in Kodi is relatively straightforward, but you need to make sure you select the right media type.



Plex makes you specify what type of media you're adding before you select a folder.



In both Plex and Kodi, we'd suggest syncing your display to your videos; this will prevent screen tearing.

click it and select the type of media you're adding, then browse to the location and click 'Add' and then finally click 'Add library' again. Keep going until you've added all your movies and TV shows – if you're adding folders that are shared from other devices on

your network, having them mapped as drives can make it a bit easier to find them.

Now, as long as you drop any new media files into these locations, Plex and Kodi will automatically add them to your library and grab all the

Need TV recording?

Neither Plex nor Kodi have PVR features built in, but there are alternatives and methods to add this. Check out these applications for more details.

- **MediaPortal** — www.team-mediaportal.com. This Windows standalone app can completely replace Kodi or Plex and has a very active community. It's the go-to replacement for Windows Media Center now that Microsoft has discontinued the latter.
- **MythTV** — www.mythtv.org. This PVR app for Linux has been available for many years now and its surprisingly robust and full-featured. It's also available as a standalone 'appliance'-style Linux distribution if you want to create a dedicated device just for running it.
- **NextPVR** — www.nextpvr.com. A free (but not open-source) application for Windows makes a good alternative to MediaPortal, especially if TV-recording is your highest priority. It can also serve as a TV back-end for Kodi.

associated metadata. If you want to add more media folders to Plex later, you'll find a 'Library' section on the left-hand side of the web interface; hover over it and click the '+' button, then follow the same steps as before to add additional folders. Likewise if you need to add more folders to Kodi's library, just repeat the earlier procedure.

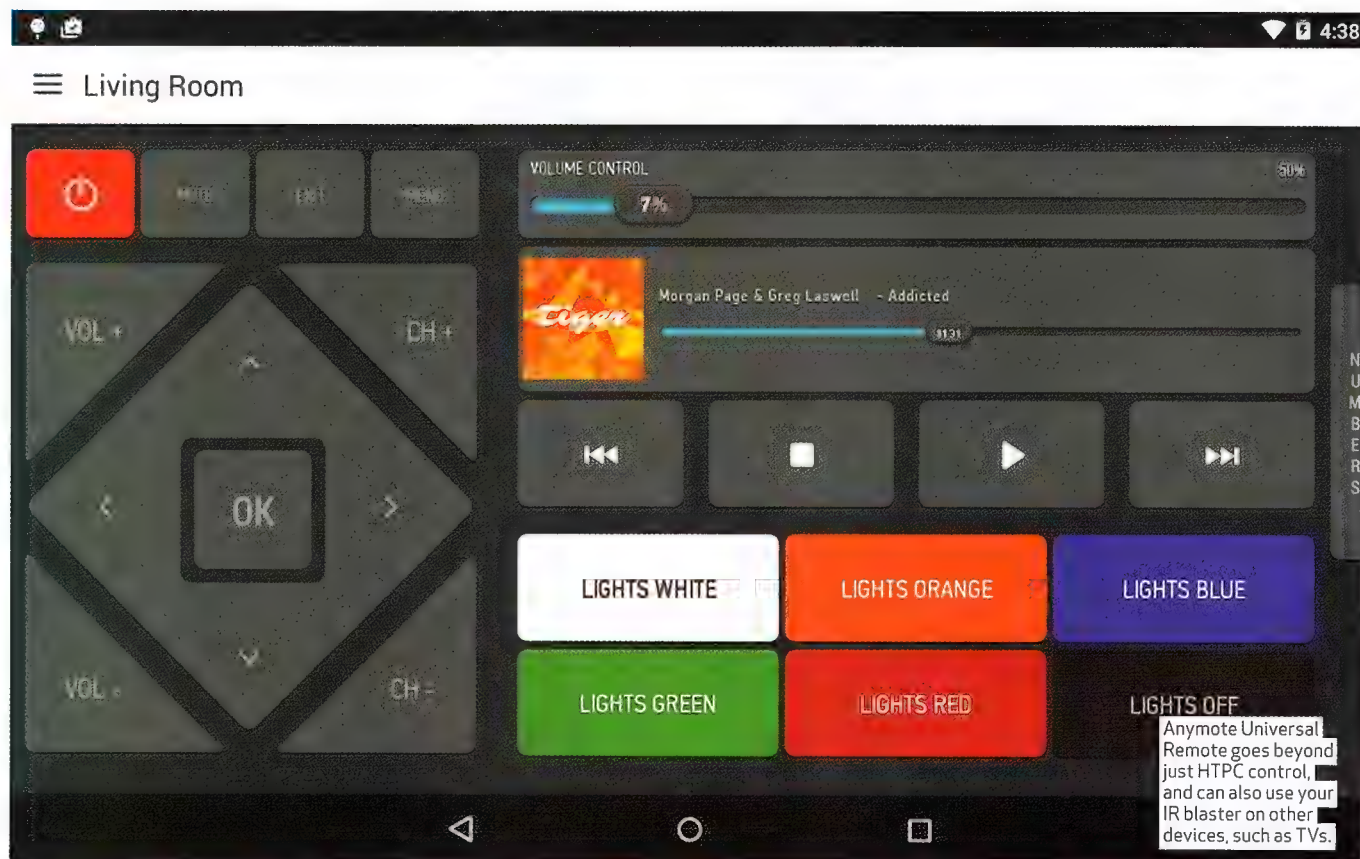
OTHER SETTINGS TO CHANGE

The defaults in both these players are configured for good media compatibility by default, so you shouldn't really need to change anything – they'll work fine out of the box. We often do go in and tweak one specific setting, however – the 'sync display' refresh rate setting, which will prevent screen-tearing artefacts and keep your video nice and smooth.

To do this in the Plex Home Theater app, head to 'Preferences > Playback > Advanced video' and switch 'Adjust display refresh rate to match video' to 'On start/stop'.

In Kodi, navigate to 'System > Videos > Playback' and, as in Plex, set 'Adjust display refresh rate' to 'On start/stop'.

And that should pretty much get you sorted in terms of the basics. Now all there is to do is sit back and enjoy your flicks... Happy watching! ■



Control a lounge-room PC with a smartphone or tablet

Lindsay Handmer [explains how to use your mobile as a couch controller.](#)

A dedicated HTPC is a great step up from a more basic media player, but sometimes the experience of using a computer does not translate well to the lounge room. While there are a range of dedicated remotes, or mini keyboards and mice, that can make control easier, there is also another way. With a familiar and easy touch-based interface, smartphones and tablets make excellent controllers. In fact, with a few apps and setup tips, you may never need to leave the couch again.

UNIFIED REMOTE

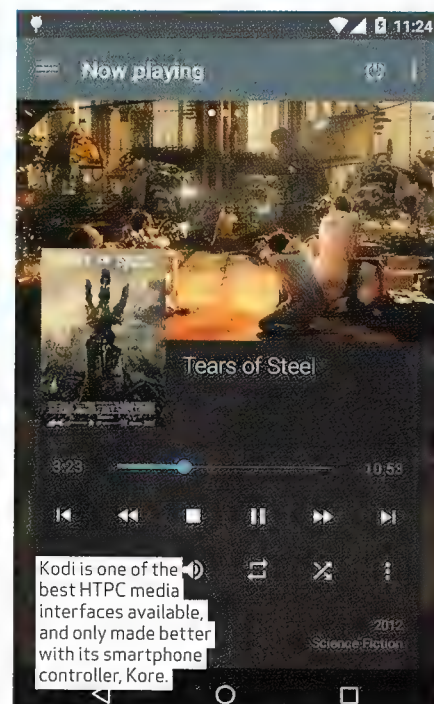
www.unifiedremote.com

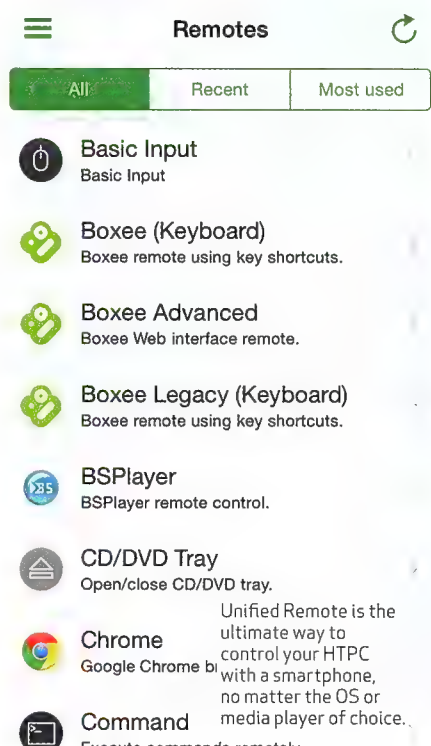
This do-all app is one of the best solutions for controlling a HTPC remotely via a mobile device and Wi-Fi. It's designed to be very intuitive to use, and automatically configures for a 'it just works' experience. Unified Remote comes in both a free version, which covers the basics, and a paid (\$4.12)

upgrade for most of the best functionality. Perhaps most importantly, it is a massively cross-platform bit of software, and can be used on just about any lounge room computer and phone or tablet combo. The controller-side app is available for the big three – Android, iOS and Windows Phone. The computer-side software is just as versatile, available for Windows, Mac and Linux. It also has installers for Raspberry Pi and Arduino, as well as legacy versions for older versions of your favourite OS.

FEATURES

Unified Remote acts as a universal remote, combining control for all your favourite programs and services into a single app. At its most basic, it replaces a keyboard and mouse, using touch input to move a cursor, click and type. You can also turn the volume up and down, play, skip or pause music and video, and shutdown/wake up the computer. The app also supports





options such as screen mirroring, and has a dedicated file browser.

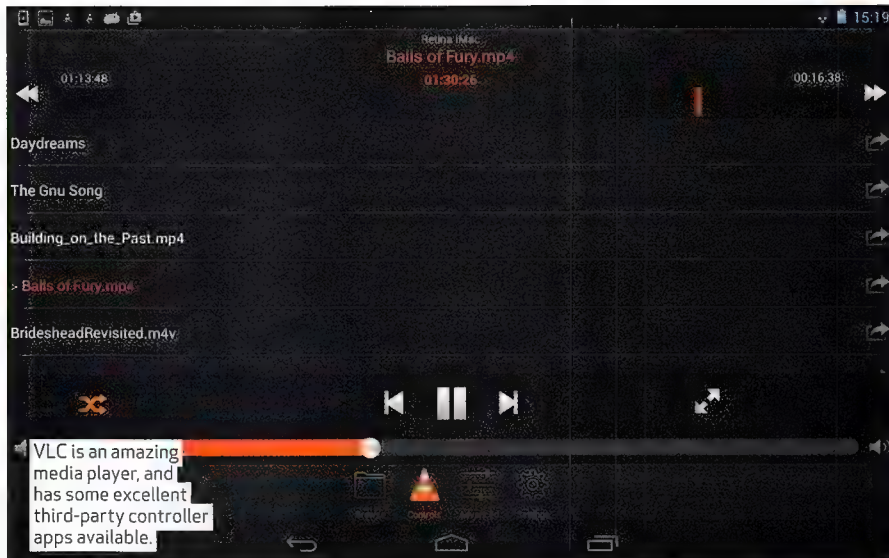
Going beyond basic control, the app has a range of remotes designed for specific PC applications. For example, it can handle iTunes, Chrome, Kodi, Plex, Netflix, PowerPoint, Spotify, Winamp, VLC, YouTube and more. The free version has 18 remotes, while the paid upgrade gives access to 90+ options, as well as the ability to create custom remotes.

Unified Remote also can create widgets and quick actions for your most used remotes. It also has voice commands, as well as the ability to control IR blasters, or set up actions based on NFC tags. It even integrates with your smartwatch. Importantly, the app creators are also continually updating Unified Remote, and working on new features such as support for Chromebooks.

GETTING SETUP

Unified Remote is very easy to get running. Download (and install) the app and server software of choice and run both. Make sure both are on the same network, and the app will automatically find and connect to the server software. The default screen shows your installed remotes, such as Basic Input and File Manager. Touching the round green '+' symbol in the bottom right allows you to browse and select more remote options.

Hitting the settings tab (top left) opens up a menu with loads of extra options and configurations. 'Servers' takes you to a list of all the accessible



server clients, where you can switch to control different PCs – such as a HTPC and your desktop or laptop. Other customisations available through the menu include mouse setup preferences, IR learning, widgets, theme options and how the app integrates with your mobile device and more.

The Unified Remote app website also includes a comprehensive help section, as well as tutorials for more advanced options, such as configuring wake on LAN. There is also an online community, with requests for specific features, and a place for people to show off their projects.

KORE (OFFICIAL KODI REMOTE)

www.kodi.tv

There is a good chance your HTPC is (or should be!) running Kodi (formerly XBMC) – just about the best home theatre software out there. To make control easier, there's an official remote app available called Kore. It's not only free, but has a very easy-to-use and stylish interface. The remote app is available on Android and iOS, and one of the best options for interfacing with your Kodi-based HTPC.

INTEL REMOTE KEYBOARD

www.intel.com

Not as comprehensive as some options, but still very handy, the free Intel Remote Keyboard app is designed for use with NUCs and Compute Sticks. It replaces a keyboard and mouse, using touch and onscreen buttons to control your compatible device. The app side of the remote is available for Android and iOS, though the server side only works with Windows.

VLC REMOTE

www.hobbyistsoftware.com

Probably the best media player out there, VLC can handle just about any

format and has loads of handy features. The problem is that it's designed for use with a keyboard and mouse, so can be a bit fiddly for HTPC use. Fortunately, though, there are a range of third-party apps available that can turn your mobile phone into an excellent VLC control system. Our favourite is VLC Remote, which has a free version as well as a paid premium upgrade for \$4.05. The app is available on iOS and Android, and brings all the relevant VLC controls together into one handy interface.

ANYMOTE UNIVERSAL REMOTE

www.anymote.io

Controlling an HTPC is all well and good, but what about the TV itself? Some phones (such as many of the HTC and Samsung range) have inbuilt IR transmitters, and can directly replace your existing remotes. The Anymote Universal Remote app and a compatible phone can control a staggering 900,000+ different devices, from TVs to air conditioners. The app also links into your Wi-Fi, and can control options such as Kodi, VLC and many smart TVs. There is a free basic version, while the premium remote with all the bells and whistles costs around \$9.

REMOTE HARDWARE

It's easy enough to use your everyday phone as a remote, but sometimes a dedicated device is better. The problem is that it's one more thing to forget to charge, leaving you scrambling for a cable just to watch some TV.

Instead, use an old phone with wireless charging – then simply drop it on a charger pad each evening. The Nexus 4, 5, and 7 are ideal, and available cheaply second hand on www.gumtree.com. Alternatively, wireless charging cases or add-ons are available through www.eBay.com.au for as little as \$10. ■



Control a Windows PC with a gamepad

Having an HTPC that can double as a console-style gaming machine is great, but between a keyboard and mouse, a remote control and a gamepad, the coffee table starts to get a little cluttered. Depending on your usage, however, it's entirely possible to ditch every input method except the gamepad, without any loss of functionality. Lindsay Handmer shows you how.

The first step is getting a suitable gamepad. If you already have one, it will likely be just fine. Otherwise, we recommend the Xbox One Controller. It's wireless, but has a removable wired connection to keep you going. Alternatively, the older Xbox 360 controller is also great. Both have excellent support, especially with Windows.

Other controllers do work, but may not be supported by some software. The top contenders are the Logitech F710 (www.logitech.com) or one of the Razer (www.razerzone.com) Xbox controllers. PlayStation controllers work, too, but are not as widely supported.

PROGRAMS AND TOOLS

Making life easy, there is a whole range of software available that helps a gamepad do the work of a keyboard and mouse. Most importantly, functions such as mouse control can be performed by an analog control stick and specific actions bound to buttons. There are also on screen keyboards designed for gamepad that let you enter text when needed.

Our favourite media software such as Plex (www.plex.tv) and Kodi (www.kodi.tv) already support the Xbox controller (and some others) by default — just check the key mapping on their websites.

STEAM BIG PICTURE MODE

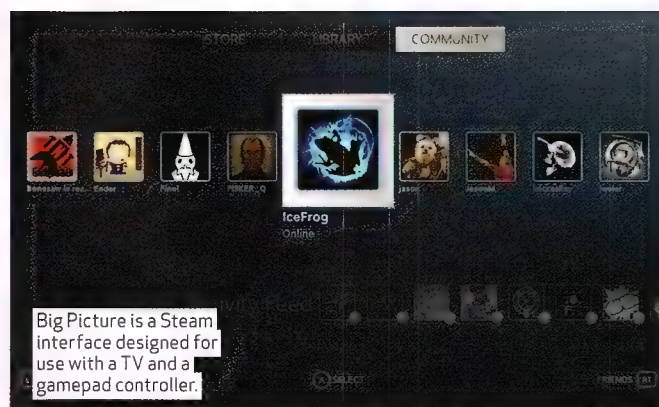
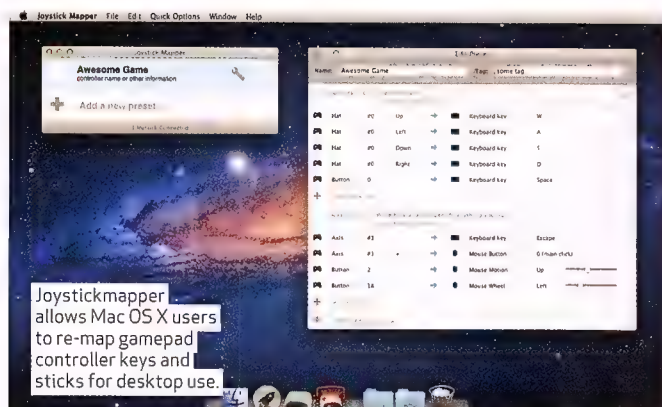
Up in the top right-hand corner of the Steam client is a little Gamepad icon.

Clicking that opens Steam Big Picture — a version of the interface specifically designed for use on TVs with a gamepad. The mode expands the size of text, and creates a simpler, easy-to-navigate interface.

Ideally, you want to launch right into Big Picture, so navigate to Settings, Interface and select 'Start Steam in Big Picture Mode'. When selecting a game to play, Steam will prompt you if the controller needs to be configured. You can use the default mapping, create your own or even try one recommended by the gaming community.

CONTROLLER COMPANION

www.controllercompanion.com Gamepad control for media or actual gaming is all well and good, but what about Windows itself? Controller



Companion is a versatile and very flexible tool that intelligently remaps your Xbox controller for Windows control. The app costs AU\$4 (US\$3) and can be purchased via the website, or through Steam.

By default, the left stick works as a mouse, and pops up a spiral virtual keyboard when pressed. The second stick works to scroll web pages, A/X is a left/right mouse click, and B works as a back button. The Y Key operates as a media player pause, and the shoulder buttons are next and previous track. Importantly, Controller Companion automatically disables itself when another full-screen program, such as a game, media player or Steam Big Picture are launched. It also powers down the controller itself when the PC is shut down to save battery power. The Controller Companion website includes some handy video guides for getting started.

GETTING STARTED

Install the software, and connect your Xbox controller. Controller Companion runs in the background with an icon (a gamepad) in the

Windows notification area (bottom right). To enable it, hold down the Back + Start buttons — the same combo also manually disables it.

RE-MAPPING KEYS

The default setup is pretty good, but one of the advantages of Controller Companion is the ability to re-map keys. Click the notification bar icon and select 'Show button help', or simply press back and the right stick. The guide shows how the buttons are current mapped — holding the back button shows secondary bindings. Clicking the left stick shows the button mapping when the virtual keyboard is open.

To rebind the keys, click the notification icon and click 'Open Settings' and navigate to 'Bindings'. From there, you can select a range of different options for each button, or create custom actions.

GOPHER360

Free and open-source, Gopher360 gives basic but effective gamepad control in

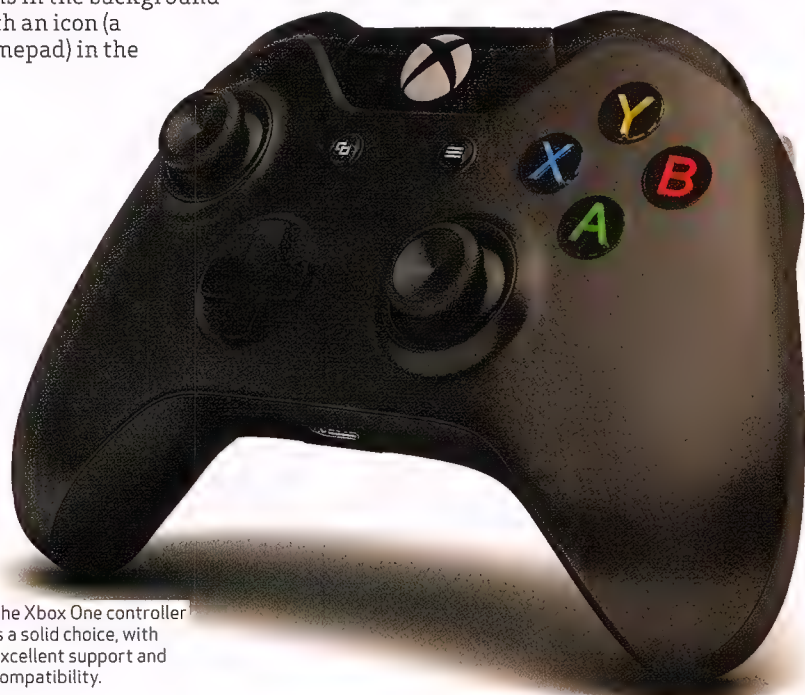
Windows. It's designed to be simple — run the program and it automatically maps your gamepad inputs. The full list of controls is available on the website (goo.gl/5mbLY7). The left stick controls the mouse, while A/X are left and right click. Start opens Windows start, the right stick scrolls, the D-pad works as arrow keys and B is enter. You can also toggle Gopher360 on and off with the Back button. Rather than having its own keyboard, the program just used the existing Windows on-screen virtual keyboard. By placing the EXE file into your start folder, Gopher360 will also be good to go.

OTHER OPERATING SYSTEMS

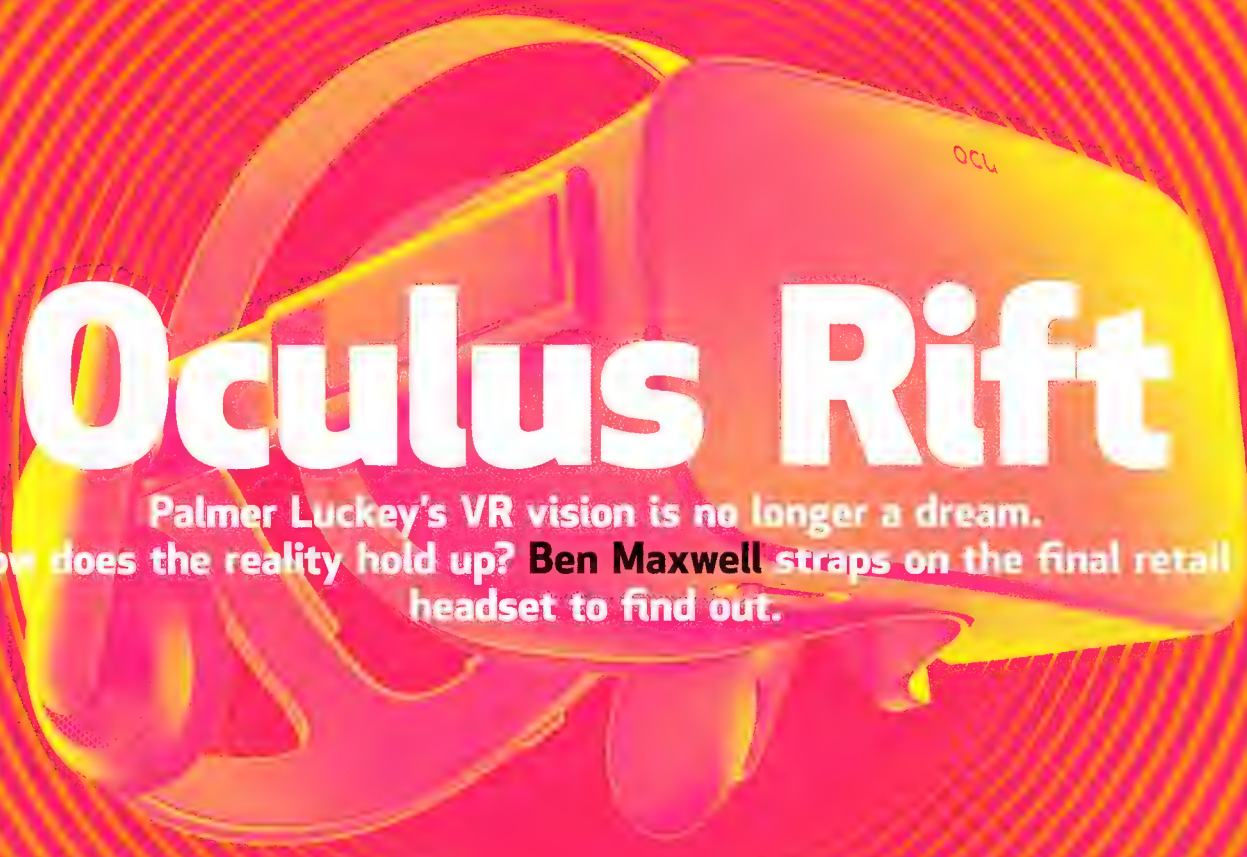
While most HTPCs run Windows, the growing library of compatible Steam games means OS X and Linux are viable alternatives, as well as SteamOS itself. For HTPC setups, Linux is a popular option and can run other software such as Kodi. Another popular choice is simply plugging a Macbook into a TV via HDMI, for some lounge room gaming or media playback.

On Mac OS X, the PS4 controller is supported natively, the Xbox 360 needs a driver, such as one from Tattiebogle (goo.gl/TIV0i). The problem is that this just gets the gamepad working in games that support the input — you can't use it on the desktop. Joystick Mapper (www.joystickmapper.com) allows you to use a gamepad to replace a keyboard and mouse, as well as re-map keys.

Up-to-date distros of Linux (kernel version 3.17 or better) actually support the Xbox One Controller natively. Some other controllers work, too, or need extra drivers, depending on exactly which version of Linux you run. For more advanced Linux tinkerers, the xboxdrv driver (goo.gl/YCG3o) has configuration options that include simulating a keyboard and mouse with a gamepad. SteamOS supports various gamepads, including the Xbox and PS4 controllers. ■



The Xbox One controller is a solid choice, with excellent support and compatibility.



Oculus Rift

Palmer Luckey's VR vision is no longer a dream. How does the reality hold up? **Ben Maxwell** straps on the final retail headset to find out.

After several years of enthusiastic, if professionally detached, experiences with virtual reality, it has finally happened. We're sitting behind a desk in a plush winter lodge having just managed to foil a poison-gas attack. An elk's head sits mounted above the roaring fireplace, and we recline to light a celebratory cigar. In the process, an intriguing panel catches our eye. It's just out of reach so we attempt to steady ourselves on the desk in order to reach across, and nearly fall face first into the floor as our arm passes through the decidedly unsupportive polygons. Later, as we remove the second-generation Touch controllers from our hands, we also try to take off a virtual hat – snagged a little earlier from a hatstand while pondering a puzzle – before tending to the Rift headset itself. Jesse Schell's virtual spy simulator *I Expect You To Die* may be cartoonish and camp, but that hasn't prevented it – with the help of Oculus's consumer-ready technology – from achieving virtual reality's holy grail: presence.

In fact, it happened several times during the time we spent with the finalised Rift hardware: an inescapable sense of vertigo while clinging to a rock face; recoiling from an object or character that looks like it's going to collide with us; and even accepting our own in-game reflection that perfectly tracks our head movements. Rift has come a long way since those first nausea-making, pixelly DK1-enabled steps around a Tuscan villa. And it says much that we spend hours ensconced in the retail headset with very few instances of discomfort. Even when they do occur, it's down to the game rather than the hardware itself.

The headset is sleek and pleasantly weighted (it's hard to tell if it has shed many grams since *Crescent Bay*, but its substance feels well distributed), and easy to put on. A comfortable plastic cradle supports the device at the back of your head while three adjustable Velcro straps, one on each side and one on top, make it easy to finesse the fit without having to continually remove and replace the headset. The integrated headphones pivot back and forth to accommodate variously shaped heads, and can even be swung out for those moments when you want to hear what's going on outside of the virtual space – a surprisingly useful consideration. A small slider under the screen housing, meanwhile, adjusts for interpupillary distance (i.e. how far apart your eyes are spaced) which, together with correctly positioning the headset vertically on your face, allows you to fine-tune the display's focus.



"[These are] the earliest attempts at VR," Luckey says. "As time goes on, people are going to figure out what works and what doesn't. The games we'll be playing this year are probably the worst VR games we're ever going to play."

"I would love to live in a world where we could make a custom Rift for every person."

Compared to older Rift iterations, the resolution is dazzling, allowing us to read all but the smallest text easily and to make out intricate details in the world, such as tiny beds of carrots in platformer *Lucky's Tale* and the clockwork-like mechanisms of *Defence Grid*'s towers. We struggle to find a setup where absolutely everything onscreen is pin-sharp simultaneously, but for the most part, an in-game shift in perspective or proximity is all that's needed to resolve focus issues. The various configurations of the human face – not to mention differences in eyesight – will make for a far broader spectrum of user experiences than is the case with TV usage, but ours is consistently comfortable.

Ensuring that such an intimate device works for every player has proven challenging, and Rift games will be labelled with one of three comfort levels depending on what percentage of players are likely to experience issues. Oculus founder Palmer Luckey admits that there have been plenty of problems to solve in order to get to this point ("I don't want to tell you what they all are; there are just so many things"), but the most difficult aspect of the launch hardware to get right had nothing to do with technical specifications – or those of the machines that it will be tethered to.

Rather, it was ergonomics that caused the biggest headaches. Initially, the company was focused on shedding as much weight as possible from the bulky prototypes, but while that seems like a logical endeavour, years of

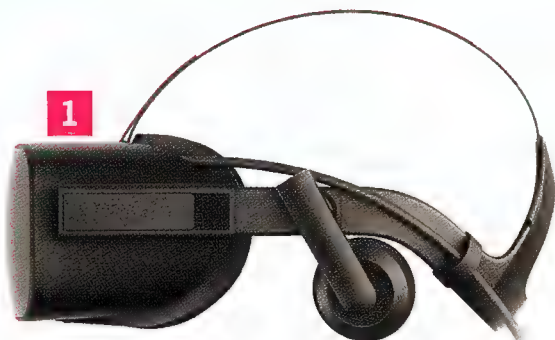
iteration revealed that carrying a little more bulk was a price worth paying for the additional comfort that could be achieved.

"With our headset, a huge amount of the weight is actually in the straps, the spring-loaded arm system and in the back beacon," Luckey explains. "If we'd just used elastic straps like DK2, we could've cut 100 grams off of the total weight of the headset, and it would've looked great in a spec war but, overall, the comfort with elastic straps was just so much worse. So we spent a lot of time doing these things to try to figure out what actually matters, rather than what's obvious and looks good on paper."

Luckey compares the problem to trying to design a pair of specs that will work equally well for anyone who wears them. "We're trying to make something that interfaces to your eyes and ears, and also has decent access to



A phalanx of VR-ready PCs are emerging that will ensure you hit those 90fps-minimum refresh rates. Expect to see bundles, too.



Rift Kin

1 Easily adjustable and light in weight, the HMD feels fit for purpose rather than flash.

2 Most people will be familiar with the Xbox One controller, which fits well with Rift's design language.

3 The constellation tracking system is easy to set up, and sits in front of you.

4 The Oculus Remote feels like something Apple might create, and proves intuitive as a way of navigating menus and options. We also spend some time playing *Dead Secret* with it. In a slow-paced game that uses warping to get around, it works well for the most part.

5 The Touch controllers are the missing piece of the package, which are unlikely to be missed by anyone yet to try them, but which offer a profoundly more immersive experience: seeing your hands in-game, and being able to interact with characters and objects so directly, is spellbinding





"90fps seems to be the point at which things just kind of work for the human eye."

your mouth for a microphone. So it needs to be adjusted for multiple input and output systems, and we want it to be usable for the vast majority of people that are out there. I would love to live in a world where we could make a custom Rift for every person that perfectly matched their face, but unfortunately that's not how the realities of manufacturing work out."

Until that time, Rift makes a pretty good fist of catering for as many people as possible. And once worn, it's easy to use, too. Games and software are launched from a 3D lobby area that feels like a grander spin on GearVR's menu: options are clearly presented as floating panels around the space, and selecting something is as simple as looking at it and tapping a button on your controller or Oculus Remote. Pressing the Menu button at any time (either in the lobby or during gameplay) brings up a more traditional-looking menu screen that enables you to make various adjustments, including re-centring your view should you find that it's drifted during use. In the setup we try, the controller's View button is temporarily dedicated to this function, which proves more convenient than the three button presses and paused game required by the options-menu route. But while this binding won't be the default, we're told that developers are free to reinstate it in their own games if they choose, and in any case, we rarely need to use it during our extensive time with the hardware.

What we play during that time looks great, but the sheer processing effort required to run a VR title means that particle effects, polygon counts and post-processing filters need to be dialled down a little. The first wave of

VR users will have to come to terms with the fact that donning an HMD isn't quite like wrapping a 1080p display around your head — at least not yet. The novelty of being placed inside a gameworld should do much to ease the transition, however, and the resultant need for developers to prioritise stable, high framerates over graphical grandstanding is having some positive knock-on effects, too.

"In the past, games have focused a lot on the graphics," Luckey notes. "People are going to keep doing that in VR, but if you have a PC that's running a game in VR, where you're having to render at 90 frames a second with lots of antialiasing in stereo 3D, and make sure you don't drop frames ever, versus one that's running it in 2D at 30 or even 60fps on a 1080p display, the graphical fidelity is obviously going to be lower for the virtual reality version. But that doesn't mean that you'll be less impressed by it, and I think we're seeing a lot of people making games that are carried by the gameplay rather than graphical fidelity as a result. Even some of the best VR games, you don't look at them and say, 'Wow, compared to modern PC titles, that's a really stunning-looking title.'"

"So developers really do have to focus on the things that matter. They have to focus on interactivity, they have to focus on depth, they have to focus on replayability. And that sense of 'Wow — there's depth and motion, and it's all around me' kind of wears out once you've played in VR a lot. Once you get past the demo stage for people who are trying VR for the first time, you can't have a game carry itself on whizzbang graphics."

Included in the Rift box along with *Lucky's Tale*, *EVE: Valkyrie* is a bold, convincing justification for your new purchase.





Q&A with Jason Rubin

Head of Oculus Worldwide Studios

Having made his mark on videogames as the creator of *Crash Bandicoot* and co-founder of Naughty Dog, Jason Rubin dabbled in social games with *Monkey Gods* before taking over as president of then-ailing publisher THQ. Today, he heads up Oculus Worldwide Studios.

How does Oculus Studios's focus differ from the company's third-party relations?

So, there's actually a lot of grey area. Every developer has a different story, and different needs, and we basically do whatever it takes to get those games to come out. AirMech, for example, started as a third-party group that was making a game but wanted some financial and production help. And so they went from our third-party group to my group and became an internally funded and helped title.

How about first-party projects?

I came in and saw everything [Oculus's two game researchers] had worked on and there was a little game that explored how to do third-person in VR. It was awesome. I found an external group that I'd worked with before, called Gunfire, and they fleshed that out into a full-fledged game called *Hero Bound* [for GearVR]. Then, inspired by this room-to-room thirdperson character, Gunfire said it could do better for Rift and had new ideas about room transitions to solve some of the issues that *Hero Bound* had, and the second generation of that is *Chronos*.

Can the problems of first-person VR locomotion be solved?

There is an inherent challenge in VR and locomotion, just like you can't make a boat that won't make people sea sick. Having said that, over time we'll figure out how to create something that's like locomotion. We won't take *Call Of Duty* and literally translate it and solve that problem, but we'll figure out how to make a game that plays like a first-person shooter that allows you to traverse without warping. What exactly that looks like, I don't know. The next generation of warping is tunnelling, which is where you can look all around you while standing still, and as soon as you start moving, you only see a small amount of the screen in front of you move and the rest of your periphery stays still. Then when you stop, you see all around you again. I don't think that's the end, but it's the next step.

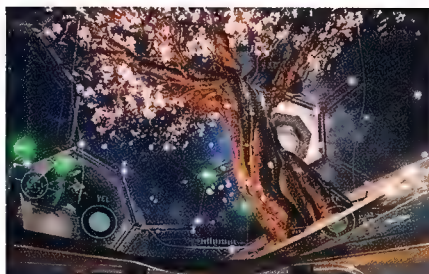
How have the lessons you've learnt fed back into hardware design?

On this hardware there hasn't been a huge amount of impact. Software's taking what it's given and figuring it out. However, things that everyone thought would be incredibly important actually turned out to be less important — I can't say exactly what those things are — and there are other things that software would really like to see that will probably be accelerated into sequels of the hardware. But the Rift is a fantastic device and we won't get to a point where we feel like we've maxed it out for a long, long time.

"It's made developers far more rigorous," agrees Oculus head of worldwide studios and Naughty Dog co-founder Jason Rubin. "When you're making a videogame and are trying for 30 or 60fps, if you drop a frame, you probably don't even notice. If you drop a lot of frames, you will, but you don't have to be perfect, you just have to be mostly there. With VR, missing a frame is noticeable by most people, and that changes the way developers think about making games. They leave a lot more headroom, and they have fewer explosive moments. Because when you do something like a huge explosion, there are a lot of translucent polygons, and that's when the framerate goes down. Having said that, all the developers that are working on this stuff get to a headspace where they're totally fine. It just takes a different way of thinking; you're just more careful. And I think, over time, it will become a non-issue — it will just be the way you make games.

"Also, 90fps seems to be the barrier. It seems to be the point at which things just kind of work for the human eye. We don't need 1,000fps, so as processors get better and as all of our computers get more powerful, it becomes easier to hit that target. That's not to say that developers won't take every inch that they can of that extra processing power to make it look better, but it will become easier. Processes will change, the way code is written will change, and processors will get better. We'll just get to the point where it won't matter as much and we'll get better at it. And there'll be systems that kick in when we're going to miss a frame to help us make it; we'll create new ways of guaranteeing the framerate."

Indeed, everything we try maintains a rock-solid framerate throughout, and we only run into serious problems when, for example, our space suit snags on some polygons in *Adrift*, causing our position to quickly oscillate between two points for a moment, and when horror game *Albino Lullaby* lets us loose with full FPS controls and we can't help but circle-strafe around corners with the run button firmly depressed. In both cases, keeping still for a moment afterwards rapidly subdues any sensation of motion sickness. But *Adrift* also lets you close the view down to a myopic tunnel by holding the B button, the effect offering immediate relief without requiring you to stop moving about in the world. It's a rudimentary implementation of a technique known as 'tunnelling' (see Jason Rubin Q&A, left), a conceptually complicated but mechanically simple idea wherein you enclose the player's peripheral view of the world when they move, but open it



Adrift

Developer Three One Zero
Publisher 505 Games

We've played *Adrift* before, of course, on one of those old-fashioned flatscreen monitors, but it's no match for experiencing the game in VR. The moment we venture outside the orbiting wreckage of an erstwhile space station and look down, the view slightly obscured by the inside of our helmet, we wonder what tiny fraction of the life-changing experience astronauts describe we're currently getting. Profundity aside, another realistic addition is the nausea you'll feel as you try to acclimatise to moving in zero-G. It's quite horrible, in fact, but Three One Zero has built in a helpful stabilisation button to get you upright and still again, and another that offers effective 'VR relief' by limiting your view to the centre of the screen. Once acclimatised, however, *Adrift* becomes a claustrophobic wonder in VR.



I Expect You To Die

Developer/publisher Schell Games

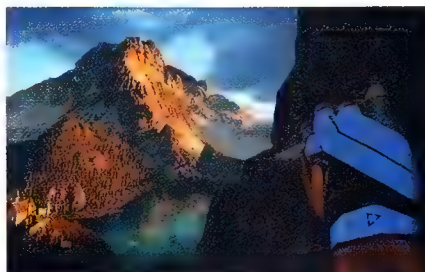
This first-person puzzle game casts players as a spy in a spot of bother. Each scenario places you at the mercy of various merciless traps, and challenges you to emerge from each situation shaken but not interred. Compatible with Touch controllers, the game keeps you seated in one position but grants you the useful power of telekinesis to grab or place objects in the distance. In the game's first scenario, for example, you can use it to retrieve a screwdriver from outside of the car you find yourself in, which is parked in the gas-filled belly of a plane. On another mission, we use it to light our cigar in a winter-lodge fireplace and manipulate a concealed lever. We don't, however, recommend experimenting with holding the gun to your head.



Chronos

Developer/publisher Gunfire Games

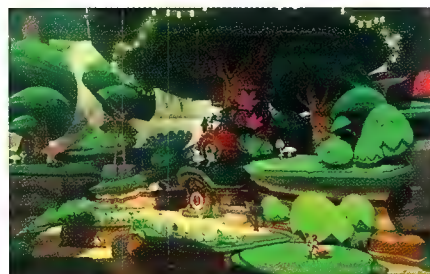
Evocative of *Ico*, *Dark Souls* and *Infinity Blade*, *Chronos* is a moody action RPG set in a bleak post-apocalyptic future stalked by terrifying creatures. Predominantly played in third-person, it uses fixed camera points as you run about its world solving puzzles, opening shortcuts and slaying enemies. The viewpoint switches to firstperson during cutscenes or when, for example, you're reading a document or using a computer screen. Combat is deliberate and methodical, requiring shrewd use of your shield and rolling, and the towering bosses are an imposing presence. Portals between dimensions open the way to a fantasy world (enabling a clever use of first-person that lets you peek through to see where you might end up), and each time you die, every enemy will respawn and your character will return to the most recent checkpoint a year older.



The Climb

Developer/publisher Crytek

With some bouldering experience and a steadfast case of moderate vertigo, the prospect of our session with *The Climb* is as daunting as it is appealing. Clambering out of a cave in the Alps — the second of the game's locations to be revealed — and then out into the blinding sunshine over a perilous-looking drop is nerve-wracking, and the combination of needing to keep the triggers gripped to stay on the rock face with the stress of looking for the next handhold proves genuinely physically exhausting. But while the pad mapping works well, *The Climb* feels stymied by the absence of Touch controllers — leaning your head closer to a hold in order to reach it feels considerably less intuitive than stretching out an arm.



Lucky's Tale

Developer/publisher Playful Corp

The most striking thing about your first moments in *Lucky's Tale* is how evocative of N64-era Rare platformers it all is. The world's packed with colour, the game's design and animation is instantly appealing, and the threateningly cute enemies rhythmically strut about the place guarding gold coins. And then there's the music, which brazenly pays homage to *Mario*'s best themes. It's an appropriate sensation for one of the first wave of games to usher in a seismic shift on a par with the introduction of 3D graphics. The revolution might not feel so profound in this particular platform game, at least from the early levels we try, but surveying the busy, living world, discovering new paths, and craning to look up through towering tree trunks as we ascend their interiors makes for an inarguably beguiling journey.



Project Cars

Developer/publisher Slightly Mad Studios

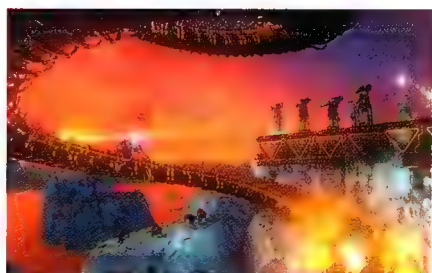
Project Cars has been compatible with DK2 for some time now, but the game's car models are done greater service by the final hardware. Yet even when afforded the ability to look around, it's remarkable how little you'll tear your eyes from the road ahead when racing in VR. Even so, the benefits of wearing an HMD are obvious: while the violent buffeting and stench of burning carbons might be absent, the sense of being sat in a physical vehicle is a considerable leap closer to taking part in a real track day or race. The feeling of sitting low in a bucket seat with the car's protruding form around you dramatically increases the sense of speed and acutely changes the way you judge oncoming corners.



AirMech Command

Developer/publisher Carbon Games

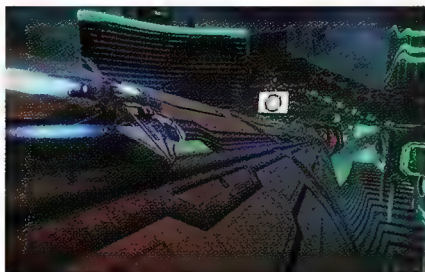
AirMech is a fast-paced action RTS in which you control a transforming robot and direct armies of AI-controlled tanks and soldiers. Like *Defense Grid* (below), it existed for some years before its creators had the opportunity to realise their ambitions with the addition of VR. In this instance, Carbon Games wanted to create the sensation of playing with toys that come to life, a fiction rendered convincing once placed into the world via a headset rather than looking into it through a monitor. Stood inside a bunker, you play on a map that represents the action taking place outside and attempt to defend your position from other players while building units and taking control of other facilities. *AirMech* is immediate, satisfying fun and, in its new form, fits into a category of VR games termed 'tabletop' that's becoming increasingly well populated.



Defense Grid 2: Enhanced VR Edition

Developer/publisher Hidden Path

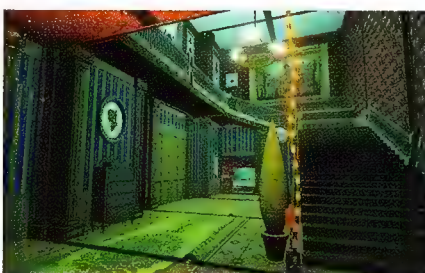
The *Defense Grid* series began life in 2008 with *The Awakening*, and spawned a 2014 sequel. This is a version of the second game refitted for VR, and it's had an extensive makeover. The controls and UI have been rebuilt from scratch to allow you to choose towers simply by looking at the spot you want to place them, and you can now zoom into any tower to get a close-up view of the action as you obliterate waves of tactically inadequate drones. There are hidden powerups dotted about levels that will require you to lean in and search behind objects, and a handful of new levels take advantage of Rift with multitiered, convoluted map designs, which also force you to move about in order to keep a track of the invading armies.



Radial-G: Racing Revolved

Developer/publisher Tammeka Games

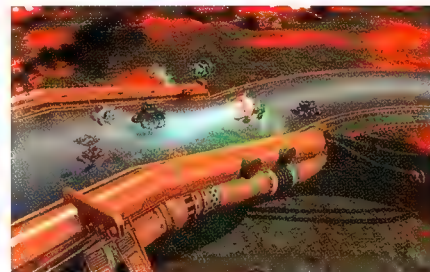
Simultaneously developed for monitors and Rift, *Radial-G: Racing Revolved* is a dizzying sci-fi racer that pitches you into terrifyingly fast races along the outside of metallic, tubular tracks. If you think that sounds nausea-inducing, you'd be right. However, the reassuring presence of your cockpit goes some way to mitigating the effect, and only sudden sideways sweeps prove unbearable — something you'll be doing often to avoid the frequent red energy barriers that slow your craft — while most other manoeuvres simply take a little getting used to (although we certainly don't recommend racing on the outside edge of a bend for any significant amount of time). To top it all off, the game — which is clearly in thrall to Nintendo's *F-Zero* — clips along at a blistering pace even on easier difficulties.



Albino Lullaby

Developer/publisher Ape Law

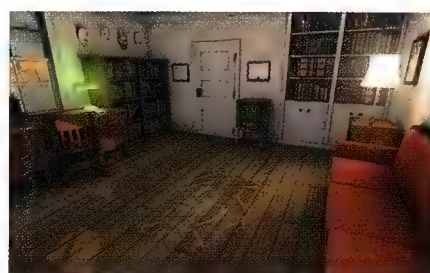
Albino Lullaby is one of the few games we tried that feels ill-suited to VR — at least in its current form and for our innards. The surreal horror game does little to ease VR players into things, its lurid colour scheme and standard FPS controls combining to quickly turn the stomach. Taking a short break from dashing about the ever-shifting mechanical levels provides relief, and the feelings of nausea quickly subside, but they return in step with the very next circle strafe manoeuvre. Which is all a great pity given that Ape Law's unnerving world is exactly the kind of place we'd like to spend some VR time in. For now, we'll stick to the vanilla PC build, but hopefully the studio can find a way to ensure that all of its stomach-churning content is intentional.



BlazeRush

Developer/publisher Targem Games

Another tabletop effort, though this time in the form of raucous multiplayer kart battler *BlazeRush*. A relatively simple port of a game that was originally released on PC and PS4 in 2014, Targem's racer shows how well some existing concepts can translate to VR with little tweaking. Structurally, the game remains the same, offering three gameplay modes (Race, King Of The Hill and Survival), a selection of tracks filled with weapons and boosters, and a large fleet of unlockable vehicles with varied characteristics. The only dramatic difference is the fact that you can now look about the place as you track alongside your vehicle, floating just above the course. But you do feel a greater connection to your diminutive vehicle, which somehow feels more vulnerable as it's jostled about in a miniaturised death race.



Dead Secret

Developer/publisher Robot Invader

Dead Secret is a first-person horror thriller in which you investigate a recent murder, encountering a series of creepy supernatural phenomena in the process. Robot Invader solves the issue of uncomfortable movement by allowing players to warp between key points, and rotate through the compass points when they get there. It makes for a pleasant, if staccato, way of gadding about the place, and ensures that the business of sifting through evidence and solving puzzles is entirely nausea-free. Robot Invader employs plenty of horror clichés along the way — crows at the window, a TV that switches itself on, an eerie figure appearing behind you in the mirror — but they're given a fresh lick of fright by the new perspective.

up again when they stop. But clever visual chicanery and reduced rendering ceilings aside, the fact still remains that you'll need an extremely powerful PC to run any of this properly – a minimum specification that, according to Nvidia, only 1% of PCs currently in use can meet, the company estimating that the average PC will require a "sevenfold increase in raw performance" to run top-tier VR. Mobile-based devices such as GearVR and Google Cardboard might provide cheaper alternatives, but they lack the comfort, positional tracking and processing heft that a full Oculus setup provides. To a company attempting to catalyse a VR revolution, you'd expect that Nvidia's estimate would be an unnerving statistic, but Luckey isn't perturbed.

"What we're showing with the Rift is at that minimum baseline for giving a good VR experience."

"Rift is an early-adopter product, but that's still a huge market – there are lots of devices that never leave the high-end PC gaming market and still sell millions of units," he says. "And there are at least a few million [GTX] 970s out there, let alone competitors' cards or Titans. Those are just the people that have it today – in six months or a year, it's going to be a very different figure. And if you look two years from now, the low-to-mid-range cards will be beating a 970. So that number's going to increase really rapidly."

"What we're showing with the Rift is about at that minimum baseline for giving a good VR experience, and that's one of the reasons you see a lot of VR headsets all being pretty similar when it comes to specifications. It's the best that can be done today and it's right around that bare-minimum experience – it's only recently the technology's become possible to provide good consumer VR. But if you look two or three years into the future, that minimum bar isn't going to change. Yes, the best-looking games are going to go up in power and require the best graphics cards for the best fidelity. But even in five years from now, you'll still be able to run a good VR experience, one that runs at 90fps or higher, in stereo 3D with good graphics, on



Q&A with Anna Sweet

Head of developer strategy, Oculus VR

Anna Sweet started in the game industry at Microsoft, designing user-research and testing tools for Microsoft Games Studio titles before spending six years working on Steam at Valve. As Oculus head of developer strategy, she now looks after third-party studios working with Rift.

Given the requirements of VR, how do you approach working with studios?

We're not very prescriptive. We generally think these developers are amazing and way smarter than us. They come to us with an idea, and we're like, 'OK, let's enable you with hardware.' We have a really great team of engineers who can help them solve their problems with performance issues. We're happy to help them at any point that they need, but we generally let them do their awesome, amazing, creative, inventive things, and then, when they're ready, we work with them to get the game in the store in front of customers. And we announced the US\$10 million fund for indie developers to help them jump in and start building for VR back at E3.

Are there any concerns about the comfort-level labelling?

There's going to be a really broad spectrum of gamers [using VR]. We see it within our own team — we all have different things that make us a bit more or less uncomfortable, but there's a game for every single one of us.

What are the standout VR development lessons you've learned?

It's all being rewritten right now. Everything from where a menu should go and how it should work, to hand collision and understanding how we're going to interact in space. And with movement, everyone was like, 'First-person motion will never work,' but now we have a whole bunch of first-person games that are really comfortable and really fun to play. And the [developers we work with] are the ones that are getting to invent all this cool stuff.

There's a big need for the industry to start thinking about players in different ways, right?

I think so, and I hope so. I hope this is a platform that's going to reach all different kinds of gamers and consumers. I think you already see that in the spectrum of games and breadth of content. Virtual reality is just a completely different medium that will attract a completely different set of people than we've had in the past.

What are the challenges of growing VR's initial audience?

I think that our first customers are going to be some of our best sales people. They're going to take it home and show it to their partners and friends. VR gets people really excited and makes them want to show it to people. We also have a really great marketing team here who are thinking about what are the right experiences at retail, and how do we really get this in front of people? Because the best way to experience it and really see the magic is to just try it.



Q&A with Palmer Luckey

Founder, Oculus VR

Palmer Luckey is disarmingly confident for his age. And with good reason: the 23-year-old Oculus VR founder has spent the past five years working up to this moment, from building a prototype in his parents' garage to being the head of a company that was acquired by Facebook for \$2bn, and which now employs star industry names such as John Carmack.

How does it feel to have reached this point?

I don't want to be flippant, but it mostly feels exactly the same right now. We're still getting there. When we launched the preorders, a lot of people said, "Wow, what a weight off your shoulders this must be!" And I'm like, "We haven't even launched — this isn't a weight off my shoulders." It's the final commitment, it's a stake in the ground where you say, "We now have to ship on this date we promised and everything has to work. Everything needs to be good." So right now, I'm not standing here saying, "Wow, we did it. We made it."

Do you think your current pace of iteration can be maintained post-launch?

Remember that we started shipping DK2 in July 2014, so it's been a while since then. [Launching] might slow us down a little bit, but I think we're going to keep seeing pretty rapid advancement — I don't think you're going to see the Rift come out and then it's the same thing for the next five years.

Part of that pace has come from the open collaboration within the industry, but how do you square that with the need to be commercially successful?

There are two things that we're trying to do. The first is trying

to make ourselves successful, obviously. The second is trying to make virtual reality successful. And so the question is, who's our bigger opponent right now? Is it other companies in the VR space, or is it public perception or ignorance of virtual reality? We're all working together to try to convince the public that it's worth wearing something on your head to use a computer. And so if someone becomes convinced by us or any other company, that's OK — it ends up being a net win right now. Because it's not like we've saturated the market and now we're fighting over market share. We're not even going to capture a tiny fraction of the total potential VR market in these next few years.

What are your thoughts on Vive and PlayStation VR?

Different people have different incentives for collaboration, and to what extent they want to collaborate. Some companies want to be in the hardware game; some want to be in the software game. Some companies, like Sony, want to be in both and controlling the entire stack. We've talked about the fact that we don't make money selling the Rift — we make money selling software. And we want to work with everybody in the industry so that we can sell more games to more people — there's no reason for us to want to limit it to our hardware. Which is different from Sony's model. And so everyone has conflicting motivations. It's unfortunate that everyone can't have the same motivations and be perfectly aligned, but that's the real world... I think the Vive is more difficult, because it's a partnership between HTC, which is a company that wants to make money from selling hardware, and Valve, which wants to make money from selling other people's software... It's two parties that maybe have different motivations, which don't necessarily align with each other's.

"We're all working together to try to convince the public that it's worth wearing something on your head to use a computer."

What does John Carmack bring to the company?

He's one of the smartest programmers out there. He has a deep understanding of hardware and software. He's been building realtime 3D applications pretty much longer than anyone else. His contributions are huge. John works in Dallas in his own office and is primarily focused on mobile virtual reality, so while he's involved to some degree in a lot of things, he's mostly been focused on mobile VR. That's what he came to Oculus to work on, because he believes in the long run that's where a lot of this stuff is headed. Not necessarily towards mobile-phone-based headsets, but towards headsets that render everything themselves.

Looking back, how do you feel about that Time cover?

I loved the cover. I thought it was great. There were a lot of people who imagined I must be devastated or embarrassed, but the reality is I have no embarrassment at all. I thought it was incredible. A lot of people thought that it was a little hokey, but it got more people talking about virtual reality that week than any other cover could have. If it had just been me smiling on a cover — who cares? But you show something that piques people's interest and more people start thinking about virtual reality, so that can only be a win.



If you buy a Galaxy S7 to go with it, GearVR will cost you nearly as much as a Rift. For untethered VR today, though, it is the best option available.

Rift comes in an imposing black box, packaged alongside the Oculus Remote, constellation tracking system, and an Xbox One controller.

970-level graphics which, by then, so many computers are going to have."

As bare-minimum experiences go, few are as enchanting. The aforementioned sense of presence that engulfs us as we play through a number of Oculus Rift games leaves a lasting impression. But just as striking is the breadth of game styles and perspectives on show. First-person efforts are well represented, of course, but we also try tower defence and realtime strategy games, isometric kart battlers and brawlers, third-person adventures and platformers, a head-controlled spin on bullet hell, and even a couple of projects that don't neatly fit into any existing genre definitions. Crucially, all feel like smart fits for VR.

"We're at this unique point in history where we're starting over with everything that we've done before in game development," says Anna Sweet, Oculus head of developer strategy and former senior business development manager at Valve. "We have all these games that we're shipping to players, and developers are redefining [existing] genres and creating new ones that we've never thought of before. In the future, when we look back at the moment that VR really took off and got to customers for the first time, these are the developers who [we'll think of as] making the *Pongs* or the amazing NES titles that we all remember. They're the creators who are writing that history. And it's super fun to be a part of that."



Many GearVR games are getting Rift ports, which add positional tracking and, in some cases, improved visuals. *Hero Bound 2* (above) and *EVE: Gunjack* (below) are among the first wave of games to step up.



One aspect that this first wave of titles will lack is Oculus's Touch controllers — due for release later this year — and it's telling that the games that stray the farthest from traditional genre labels benefit most from their inclusion. Does Luckey worry at all about potentially fracturing Rift's market before it's even established?

"You have to remember that people have been developing VR games for gamepad for over three years now," he says. "I think if we had bundled Touch controllers with the Rift, you'd have a much stronger case for saying, 'Aren't you fracturing the marketplace by bundling motion controllers after years of development for this other input device?' I don't want to seem biased, but I want to point out that it's more like motion controllers are fragmenting the huge content base that's existed, rather than the other way around. And in our best practices guide, for years we've been telling people how to develop for gamepads. They're relying on every person that buys a Rift being able to play their game with the hardware that's included. And a lot of genres just don't benefit from motion controls at all. They're very beneficial to certain genres, but they're not a universal input tool. We're able to include the gamepad because almost all of the games made for the Rift support it, and it wasn't a huge cost to add. Adding Touch would've significantly raised the cost of the Rift."

Even without Touch controllers, Rift remains a convincing case for VR's eventual widespread adoption. That it's just the first step towards that future does nothing to undermine the profound effect of stepping into a game and forgetting yourself. But Luckey isn't ready to celebrate the company's monumental achievement just yet. "There's more pressure than there's ever been," he says. "I mean, especially when you're early on, it's important to support developers and ship our devkits, but it isn't until you make a solid commitment to shipping your final product that the pressure really starts to crank up." ■



HTC Vive

Valve's room-scale VR arrives in the home and changes it forever — for better and worse. **Nathan Brown** goes hands on.



Well, if you thought clearing off the coffee table for a *Wii Sports* session was an inconvenience, or that 20 minutes of pre-party *Rock Band* kit setup was too much like hard work, you're in for a heck of a shock. The problem with HTC Vive's ambitious, often brilliant room-scale VR is that, as the term implies, it needs an entire room.

Rarely has the phrase 'disruptive technology' been meant so literally. You're not clearing the coffee table, but picking it up and taking it out of the room; every piece of furniture and potential obstruction must be pushed right up against the perimeter of your chosen play space, or removed from it entirely. Vive requires full floor-to-ceiling coverage, too, so any location featuring fancy light fittings is a no-go.

You also need two high, diagonally opposite surfaces on which to mount its base station sensors — if you have no bookshelves, you'll need to get your drill out to install the provided mounting brackets. Oh, and we assume you've got at least three spare power points in the right places — one for each base station, and another for the junction box that sits between HMD

"The thick, three-way cable that tethers HMD and PC is the elephant in the room here."

and PC. And if you connect your PC and TV over HDMI, and your GPU only has one HDMI slot, you're going to have to rethink that, too, because Vive needs it. The arrival in the home of room-scale virtual reality means half a day's head-scratching, furniture-moving and cable-chasing, a displeased frown from your significant other, and disappointed offspring asking why their playroom's been transformed into a health-and-safety nightmare. Sorry, kids, but the future comes at a cost, and we're not just talking about the hefty AU\$1,500 price tag.

Things improve markedly once everything is installed, though the workflow for Valve's browser-based setup tutorial could do with some improvement. If we're being kind, perhaps the decision to not have you download 2GB worth of SteamVR files until after you've rearranged your entire living room is Valve

acknowledging that you could probably do with a sit down. (If only we had anywhere left to actually sit.) Once that's done, though, the fun begins, as you use a wireless Vive controller to trace the perimeter of your play space — the haptics inside rumbling near solid surfaces like a *Ghostbusters* PKE Meter — and show SteamVR where your floor is by simply



STEAM® VR

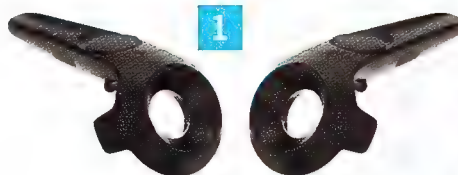
Vive is fully integrated into Steam, with installation, tutorials and driver updates handled through the PC client.

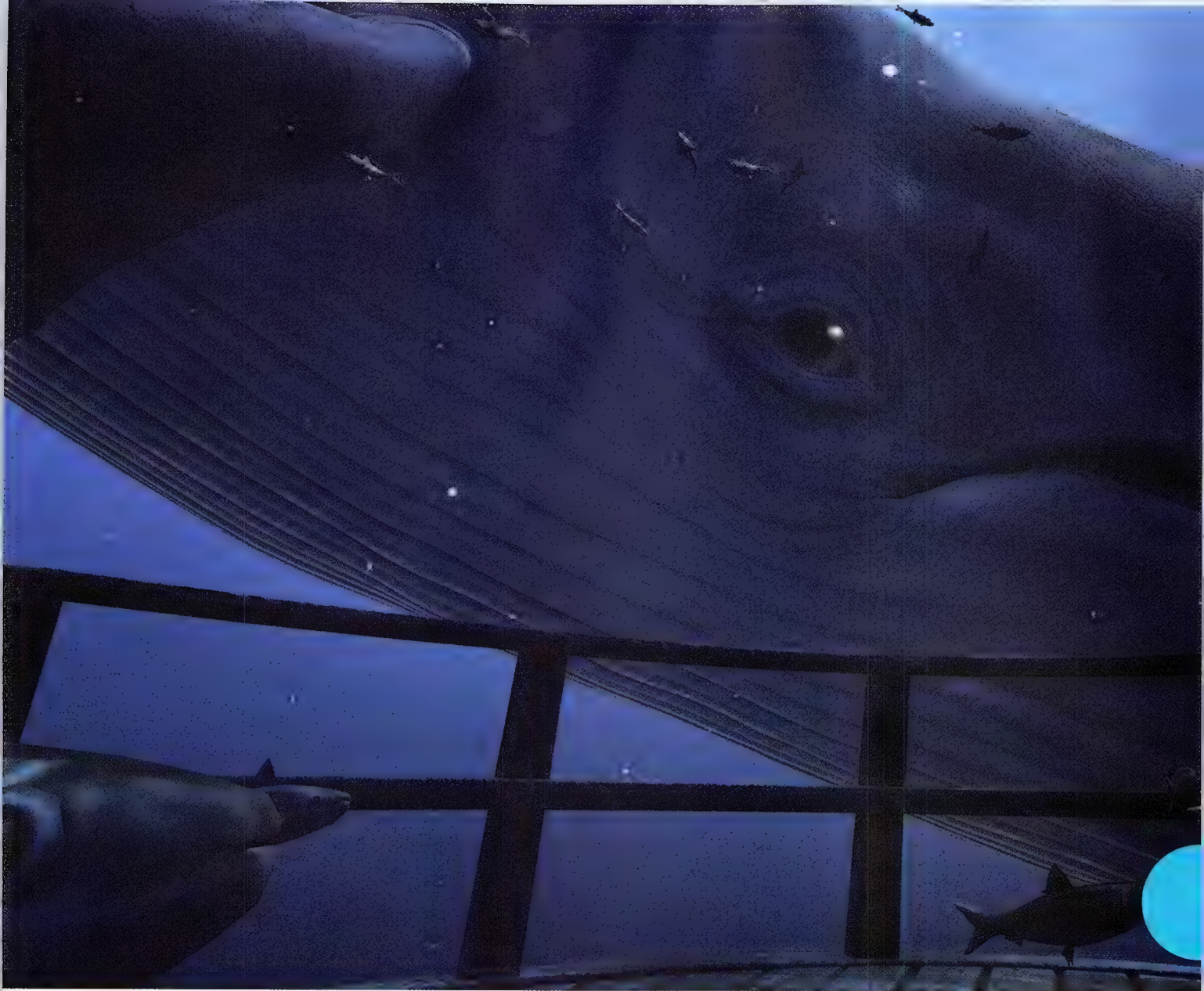
ROOM 101

1 Vive's wireless controllers are essentially souped-up Steam Controllers split in two. The rings at the top are covered in sensors for one-to-one tracking by the base stations.

2 The base stations, must be placed diagonally opposite each other. Ideally they'll be angled downwards by 30–45 degrees, but they work fine on the horizontal.

3 The HMD 03 is weighty (heavier than a Rift) but comfortable, though the thick cable running down your back is an unavoidable distraction. Dials on either side can be used to move the display closer or further away, while another adjusts how far apart the two lenses sit depending on the distance between your pupils.





"While the future of games may well have just arrived, we're not entirely sure what it looks like."

putting the controller down. If only the entirety of Vive's setup process could be so playful.

Just as things are looking up, however, it quickly becomes apparent that Valve and HTC's minimum recommended play space of 1.5m x 2m isn't really enough. Valve's flagship demonstration of the hardware is *Aperture Robot Repair*, a single-room experience set in the *Portal* universe. It immediately asks you to reach for an object that's outside the boundaries of the playspace unless your setup significantly exceeds the recommended minimum, your real-life boundaries shown on the display in gridlines and your objective a foot or so beyond. You can teleport around the room by pointing the Vive controller at the floor and squeezing the trigger, but it rather defeats the entire purpose of the hardware's USP: freedom of movement.

The Abbot's Book, an episodic indie horror game, uses a similar solution to the player's movement through a large area — squeeze a Vive controller trigger and a soft glowing light shows the next pre-ordained step along the way. Release the trigger, and you warp there. It should be an immersive, atmospheric game — and, at times, it feels like it, as you venture into the depths of some pitch-black catacombs with only a torch and a rather unsettling accomplice at your side. Instead, you have to reorient yourself every two seconds to work out in which direction the teleport has left you facing, and where you were headed next. This is an accepted design practice in VR, but it seems to benefit the creator more than the player. You shouldn't be spending your first hour with room-scale VR pining for a comfy chair and a controller, and it's a little deflating to realise that a VR solution

TheBlu: Encounter, a demo featuring a giant whale, is a great early example of how VR can emphasise scale.



that should, in theory, afford you more freedom than the sedentary experiences offered by Rift and the rest frequently feels more limiting.

Not that you'd want to walk around too much anyway. The thick, three-way cable that tethers HMD and PC is the elephant in the room here, and it's got its trunk wrapped round its legs. *Jeeboman*, a 360-degree first-person shooter, is more suited to a swivel chair than standing play, and within minutes, we're getting shot to bits after taking off the headset in order to untangle the cable from our ankles, as concerns about the real world impinge once more on our sense of being in a virtual one. These are software issues as much as hardware ones, and it's worth noting that *Jeeboman* is in development for Rift as well as Vive, despite the devices offering different capabilities. The best games on both will be built around their particular strengths rather than simply what functionality they share.

On early evidence, however, room-scale isn't Vive's USP. It's the headline feature, perhaps, but what really makes this device tick is the bundled pair of wireless controllers. Those who have used a Steam Controller will be immediately at home with the functionality: the circular, clickable touchpads beneath the thumb, the two-stage trigger under the index finger, the extra button under the middle finger, and the haptic rumble within. But they won't be prepared for the *Minority Report*-style fantasy that awaits when they first pick them up. Hold the System button, which sits just

below the trackpad, and Steam's Big Picture Mode overlay appears, allowing you to open and close games, access your friends list or browse the web. Click a touchpad in certain apps, such as the sandbox building game *Modbox*, and a menu appears on your wrist; move your other hand across and a pointer appears with which to make your selection. Rotate your left wrist this way and that and you'll find another menu, then another and another.

Modbox is Vive at its best: you're mostly stationary, moving only on your own terms within your own, real-life boundaries. Crucially, you're left to create your own fun, rather than follow instructions. Steam Workshop support means the lazy can instantly load up a game of darts, basketball or ten-pin bowling, but with a couple of clicks, you're able to start spicing things up, putting tight walls and a low ceiling around the hoop and going for improbable bank shots, or seeing how many pins you can knock down with a well-flung pool ball.

And it's through *Modbox* that we understand why VR is a cause of so much excitement from those outside the game industry. Few of the 19 entries in the VR section of our Steam library can be strictly classed as games, and but for a couple of exceptions (notably the excellent *Final Approach*, see opposite), Vive's current highlights are abstract playthings, not traditional games. Writing your name in midair using Google's wonderful Tiltbrush software feels far more like the future than opening the wrong

drawer in *Aperture Robot Repair* and being berated by GLaDOS for it. Fashioning a makeshift car from stretchy balloons in *Fantastic Contraption* is a much greater thrill than warping between pre-ordained markers in *The Abbot's Book*. On this evidence, Vive's appeal lies in doing what you want to do in a virtual world of your own making, rather than following a list of instructions left by someone else.

This goes some way — but perhaps not far enough — towards explaining Valve's disappointing lack of involvement in Vive's software lineup. The company has built its business around the concepts of partnership and delegation, whether getting the community to curate Steam's catalogue through Greenlight, or asking PC hardware companies to help coordinate its move on the living room with Steam Machines. With SteamVR, it has done both, getting HTC to deliver on the hardware proof of concept and other developers to provide the software aspect. At launch, Valve's vision of the future of games comprises a set of tutorials, the fun-but-lightweight playpark of the GDC-announced *The Lab*, and a ten-minute, vaguely interactive rollercoaster set in the *Portal* universe. It's perhaps the most hands-off launch from any platform holder in history. It means that, while the future of games may well have just arrived in our living room, we're still not entirely sure what it looks like. And what about our poor coffee table? It can't stay in the hallway forever. ■



The controllers will feel familiar to those who have used the Steam Controller.



Felt Tip Circus

Developer Alpha Wave Entertainment
Publisher AAD Productions

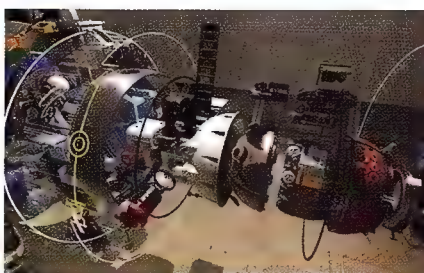
The name may imply artistry, but Alpha Wave Entertainment's game is no looker. There's plenty of charm here, however, both in setup (the circus in question is a plaything come to life on a living room floor) and execution. Knife throwing has you fling spiky balls at balloons; higher difficulty levels complicate things with gymnasts cartwheeling in front of you. Elsewhere you tame paper lions with chairs, guide acrobats across complex courses, and walk tightropes in an attempt to impress a fickle crowd. Alpha Wave admits that the audience is unbalanced right now — a single miss in a perfect run prompts a chorus of boos — but the developer's bigger challenge will be fleshing this out into something that feels like more than just a VR semi-sequel to Wii's *Carnival Games*.



Final Approach

Developer/publisher Phaser Lock Interactive

Phaser Lock's Vive exclusive doesn't exactly have the most inspiring of openings: you're in an office, with a desk, and a muzak version of *Girl From Ipanema* is being piped through a speaker. But it's just a fancy mission-select screen, and seconds later, you're overlooking a small 3D island, in the middle of a busy city, or out on the open sea looking down on a military fleet. Using the Vive controllers, you trace flight paths for approaching aircraft, deploy choppers to aid those in need, and even get down to ground level to put out engine fires and aim gun turrets at wayward drones. As effective a demo of Vive's capabilities as *Flight Control* was for the smartphone touchscreen, *Final Approach* is one of SteamVR's few current highlights.



Aperture Robot Repair

Developer/publisher Valve

We'd have expected more than a barely interactive ten-minute spectacle from Valve given its role as pseudo-platform holder for Vive and SteamVR. As delightful as it is to be back in the *Portal* universe and on the wrong end of GLaDOS's brutal wit — we're a "sweaty sack of ham", apparently — the action, if you can call it that, fades to black within minutes. You don't do much, either: opening a drawer is about as involved as it gets. Yes, it's a convincing display of room-scale VR. Yes, it's sort of *Portal*. But the overriding feeling, even after the GDC unveiling of *The Lab*, is disappointment at what might have been. Valve will get back to what it used to do best. For now, it feels odd that a company with so much to gain from VR's success has offered it so little software support.



Fantastic Contraption

Developer/publisher Radial Games, Northway Games

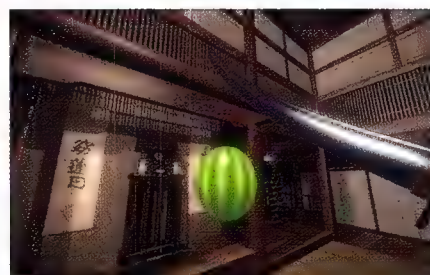
What began life in 2008 as a Flash game was picked up by Inxile Entertainment and brought to iOS, and now finds a new home in VR as a Vive launch game. There are whiffs of *Banjo-Kazooie: Nuts & Bolts* about it, as you build a device capable of carrying a balloon through a goal across the stage. Using the wireless controllers, you can resize and rotate stretchy objects with sticky edges, then hit the Play button and watch as they inevitably drift off course and fall over within a couple of seconds. Vibrant, playful and creative, *Fantastic Contraption* is ideally suited to Vive despite its age and origin — and it's already hovering up plaudits, including a nomination for the IGF's innovation-focused Nuovo award.



Job Simulator

Developer/publisher Owlchemy Labs

The comedy 'Something Simulator' label has been so overused of late that we've got an email filter set up to delete them on sight, but Owlchemy Labs's wry musing on the drudgery of cubicle life can be a delight. This subgenre's signature trick — having you struggle through a series of basic tasks while wrestling with comical physics — reaches a new plateau in VR: we defy you not to open your mouth when you tip a coffee mug to your lips, or chomp on a doughnut. Room size was a problem when we were expected to reach through an exterior wall to plug in a computer, but the biggest concern is whether Owlchemy can craft a full game out of real life at its most mundane. But it's a fine proof of concept, and almost enough to make us open up our inbox again.



Ninja Trainer Vive

Developer/publisher Atomic VR

Given Steam's recent abundance of mobile ports and quick knockoffs, it's perhaps appropriate that Vive's software lineup should include a brazen copy of *Fruit Ninja*, but it's an effective showcase of what Vive offers that the handheld screen can't. Full 3D means you have to be more precise with your swings than on a touchscreen, while the visible sword in your hand can only cut through flying groceries with the sharp end of the blade — a tennis-style backhand will simply ping your target across the screen unharmed. It's quite a workout, too. It may not be the most imaginative of Vive games, but *Ninja Trainer* is an immediate, accessible way of showing the uninitiated what HTC's VR device is capable of.

PlayStation VR

With a comparatively low pricepoint and some innovative software, Sony's VR ambitions are serious.
Simon Parkin reports.

The London Heist is now part of the PlayStation VR Worlds game compilation.



When the announcement of a peripheral that, at \$550, costs more than the hardware on which it runs and yet could be considered to be something of a bargain, you know we're living in unusual times. But then PlayStation VR's rivals cost hundreds of dollars more than Sony's hardware, and that's before you even factor in the cost of the high-end PCs that are required to make them work properly, or even shipping costs to Australia. In that context, PSVR's pricepoint, announced at a press event held in San Francisco alongside the Game Developers Conference, feels almost miraculous — especially when you consider that Sony claims it will make money on each unit sold.

Andrew House, CEO of Sony Computer Entertainment, who strode onto a small stage in front of a packed room to reveal that the PSVR will launch globally in October, seems only too aware of the coup the company has pulled. "The pricepoint has been far from an easy task," he says, smiling. Nevertheless, as the most affordable serious VR option, Sony's hardware may have the best chance, at least in the short term, of luring consumers to invest in the nascent medium. It's a tough job. While a battalion of developers and investors appear fully on board with VR's potential (e.g. the unprecedentedly long queues lining up for the Game Developers Conference's VR-themed talks), many traditional videogame fans seem less convinced of its relevance to their interests.

"Excitement for delivering VR reminds me of the anticipation when building the original PlayStation," House says, undeterred. "It's a natural evolution of the experiences we strive to deliver at PlayStation." Sony certainly has firepower. The company

"The final unit is consistent with prototypes, a visor-like HMD studded with light bars."

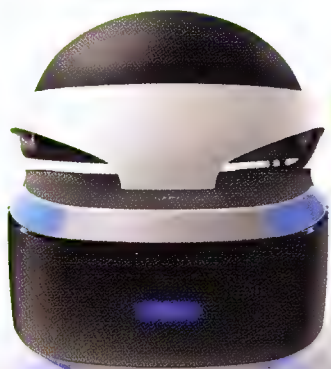
says that more than 230 studios are working on games for the device, with commitment from publishers such as EA, which has revealed that it will release a dedicated PlayStation VR version of *Star Wars Battlefront*. As yet, however, there are no details on how many titles will launch with the headset, which will be available in various bundles, the most expensive packing in a PlayStation Camera (which PSVR needs in order to function) and two Move controllers. At least Sony is able to commit to the release of over 50 PSVR games before the end of 2016.

Sony's HMD may not match up to its PC-based competitors when it comes to

particular hardware specs, but it has several immediate advantages over the Rift and Vive. 36 million PS4s have been sold to date, and all of those devices are VR-ready, while the average player's PC is simply unable to cope with the demands of the hardware offered by Oculus and Vive. And perhaps certain Sony execs have downplayed how well its hardware measures up: PSVR is capable of a 120Hz refresh rate, with a 100-degree field of view. Latency, meanwhile, is measured at less than 18 milliseconds, while audio is engineered to deliver 360-degree sound that shifts dynamically according to the player's head position. While the base PS4's



Tumble VR is a remake of puzzler Tumble, in which you arrange and stack blocks.



1



2

Play time

1 Unsurprisingly, for hardware designed by Sony, the PlayStation VR HMD is a handsome piece of technology, even if it looks a little self-consciously 'sci-fi' when compared to its competitors.

2 The processing unit handles 3D audio processing, mirrored social screen and 'separate mode' TV outputs, and displaying 2D content in PSVR's cinematic mode.

3 A PlayStation Camera isn't included in the basic box, but is essential to PSVR. The hardware currently retails at about \$85.

4 Move controllers provide your in-game hands.

5 But unlike Rift and Vive, using the standard controller doesn't preclude you from reaching into gameworlds.



3



4



5

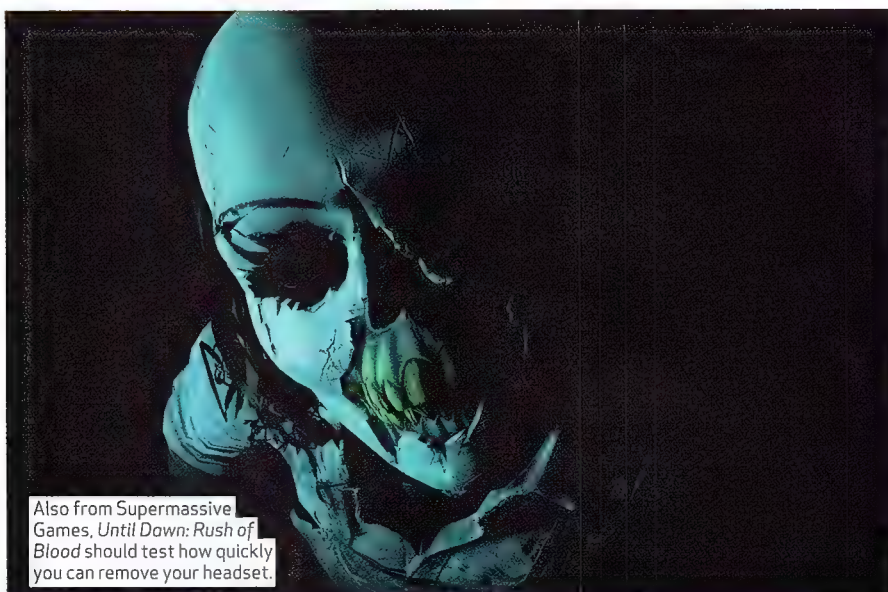




The Playroom VR riffs on Nintendo Land's asymmetric multiplayer, pitting four controllers against one headset.

limited power relative to high-end PCs may restrict the vision of certain game developers, this drawback is outweighed by the console's consistency. As House puts it, "Developers can be assured the exact experience they're working to create will be the same for all [PSVR] players."

In product design terms, PSVR is arguably the best we've seen to date. The final unit is consistent with early prototypes, a white visor-like HMD studded with blue light bars. It's easy to put on your head, with a band that can be adjusted with the simple press of a button, while a high-quality microphone set into the headset allows for easy communication. Sony has worked hard to reduce the weight of the device, and it doesn't feel particularly heavy even with prolonged use. PSVR also integrates



Also from Supermassive Games, *Until Dawn: Rush of Blood* should test how quickly you can remove your headset.

"Sony is best poised to bring VR to the mainstream due to the momentum of the brand."

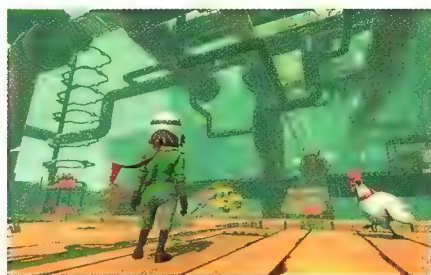


well with existing PS4 features: most system options are available while using the headset, and a cinematic mode allows you to play standard PS4 games or watch video on a virtual cinema screen whose size can be scaled according to the user's preference.

House is, however, in no doubt that the road to success will be long and winding. PSVR users will, he concedes, be a subset of existing PS4 owners. Mainstream adoption is far away and, besides, developers must first work to nail down the new language and rules of the medium, which don't entirely mesh with those of traditional videogame styles. "This is a new medium that requires new thinking and new ideas," House says. Despite the vast challenges that lie ahead, he

maintains that Sony is in the strongest position to spearhead the medium's advance. "Sony is best poised to bring VR to the mainstream due to the PSVR's value, the strength of the ecosystem, and the momentum of the brand."

Crucially, with PSVR being launched at the price of a new platform, Sony must support it as one, with all of the requisite software such ambitions demand. For the hardware to succeed in the long term, even at such an attractive pricepoint, it will need the kind of ongoing game support the company and its partners weren't able to provide for previous PlayStation innovations such as EyeToy, Move and PlayStation Eye.



Wayward Sky

Developer/publisher Uber Entertainment

Wayward Sky is one of the most joyfully inventive games in PSVR's early stable. You play as Bess, a young girl who crash-lands on an exotic continent with her father, who is summarily kidnapped. Dubbed a 'look and click' game, the action switches between a tabletop-style perspective, where you point the PS Move controller to direct Bess toward interactive objects, and first-person mode, where you interact with those objects as the girl. You might direct her to climb a crane, for example, and, once inside the cockpit, use its controls to clear a crate that's blocking her path. Back in the tabletop perspective, you must time Bess's movements to avoid being captured by the robots that patrol the world, resulting in a game of hide and seek where the urgency is heightened by your brief spells playing from her perspective.



Headmaster

Developer/publisher Frame Interactive

Ben Throop's football-themed game is unusual in that it's one of the few PSVR launch titles that doesn't require a controller. Instead, it's entirely controlled with your head: you attempt to angle balls launched from cannons into an array of different goals. But this is more than a mere sports minigame. Your quest is set within the prison-like Football Improvement Center, where failing professional football players are sent for remedial training (despite being an American game, Throop has opted to refer to the sport as football, rather than soccer). In this way, you header your way through increasingly farcical situations to earn your freedom. You progress from empty goals to goals that are guarded by cardboard keepers and, eventually, piñata. You're awarded up to three stars for each round while the warden issues wounding jibes.



Golem

Developer/publisher Highwire Games

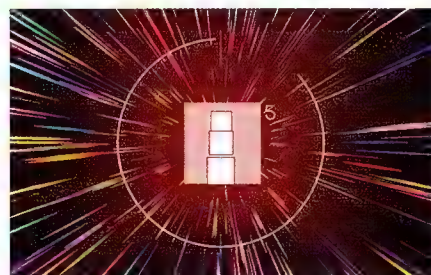
Golem's heritage is impeccable, bringing together former Bungie composer Marty O'Donnell, former Bungie game designer Jaime Griesemer, and former Airtight Games programmer Jared Nofle. You play as an injured child who, after falling from their bed, crawls along the floor to discover a world beyond the floorboards. One of the great challenges in VR is clearly character movement — the disconnect you feel when walking in a gameworld while standing still or sitting in reality causing motion sickness — and Highwire addresses the issue by having you lean forward to crawl. It's an effective technique that works just as well once you're transformed into a hulking stone golem. Combat works like a slow-motion *Punch-Out*, using the Move controller to position your huge stone sword to block, parry and counter with lingering swings.



Social VR

Developer/publisher SCE

Sony's *Social VR* demo is one of PSVR's most inventive launch apps. Set on an island, players can work and play together in the virtual space, trampolining, dancing in a disco, hurling snowballs at one another on top of a mountain, and even using space hoppers to bounce hundreds of metres in the sky. Through tracking your head and hand movements, a surprising amount of your personal character is conveyed in each avatar. Talk using the PSVR mic and the avatar's mouth flaps open and shut according to the amplitude of your voice. Using button combinations on the Move controllers, you can issue a thumbs-up or thumbs-down gesture. The dev team has plans to allow players to design their own avatars, which could work as an online project, no doubt complete with more intimate grieving than we're used to.



Super Hyper Cube

Developer/publisher Kokoromi

After years in the desert, *Fez* creator Phil Fish is set to return to game development, albeit within the larger collective Kokoromi, with the dazzling *Super Hyper Cube*. If *Fez* perfected a nostalgically twee indie aesthetic, *Super Hyper Cube* veers the other way, toward futuristic chic. You twist and flip clusters of cubes to fit through shapes in an endlessly approaching series of walls. Squeeze through the gap successfully by moving your head, and a new cube joins the cluster, adding difficulty but also a score multiplier. Misalign and you lose a life. Configurations are random during each playthrough, so you won't be able to learn patterns, while daily challenges aim to encourage online competition. The game would stand out without a VR component, but descending bodily into its abstract space accentuates its power.



RIGS: Mechanised Combat League

Developer Guerrilla Cambridge
Publisher SCE

Rocket League's influence is both clear and welcome: Guerrilla Cambridge's *RIGS: Mechanised Combat League* combines mecha with basketball, as players hurl themselves bodily through an oversized hoop in the centre of the field to score points against the other team. This is more than a pure physics game, however, as each member of the three-person teams packs two weapons and a lunging melee attack, all aimed with an elegant look-and-shoot control scheme. Each is branded with eSports-y names and garish colours, and can switch between three modes ('attack', 'repair' and 'speed'). It's scrappy, knockabout fun, so long as you can move past the hyperactive, faux-American-sports aesthetic. ■



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HARDWARE

THE CASE OF THE DISAPPEARING DRIVE

My desktop PC has recently been taking a long time to start up. Between hitting the power switch and getting to the Windows login screen can take over a minute, when it previously was less than 10 seconds. I put this down to general Windows driver cruft, but yesterday, I also saw a message about a SMART error and drive E is no longer there. This drive holds most of my applications and data, to keep as much free space on drive C as possible, so I really don't want to lose anything there. What's my best course of action?

Liam Portishead

The best course of action: replace the drive at once and restore from your most recent backup. What's that you say? You don't have a recent backup? It's an unfortunate truth that hard drives do die, so as we've said numerous times before, if you really don't want to lose any data on a drive you need to take proactive steps to protect it. Your drive has been slowly dying for a while now. The startup delays probably occur when the drive doesn't immediately respond to the SATA controller during the boot process.

This might be a sticking drive spindle, or it might be a fault in the drive electronics. The SMART diagnostics error is the flat line on a heart rate monitor that's been spiking erratically for ages. The good news is that this sort of drive failure can normally be recovered for silly amounts of money by specialist data recovery companies like www.ontrackdatarecovery.com.au.

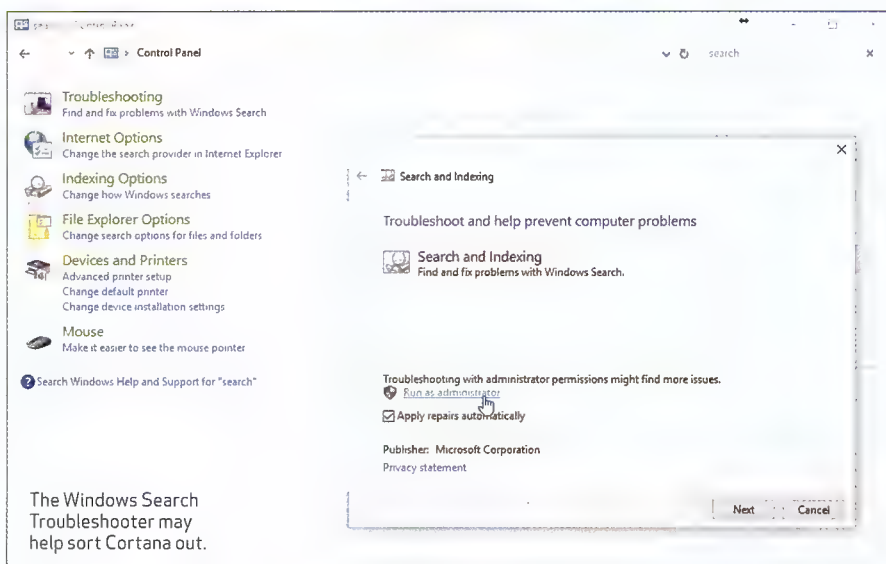
And if you're happy with the figure they quote you, by all means, ignore any of our future exhortations to back up your data.

Luis Villazon

WINDOWS

CORTANA KEEPS BREAKING DOWN

After recently getting Cortana's voice-activated system up and running in Windows 10, I've now discovered that Cortana stops working after conducting web searches. I have to clear the search history and then restart my PC to get it



If you don't want to lose something on a drive, make sure it's backed up somewhere else.



Random shutdowns on an older laptop are probably a sign of a bad motherboard.

like to make some screen shots of the games to decorate the outside. Is there an easy way to make screen grabs in DOS? I've tried Alt-Print Screen, but that doesn't seem to work. And where would I paste it anyway?

Sean Morrison

As you've probably surmised, there's no such thing as the clipboard in DOS, so there's nothing to paste from. Alt-Print Screen works in the command console because this is just a terminal app that runs in Windows. Although the console looks like the old DOS command line, it still has access to all of the Windows services running underneath.

Likewise, you can run your DOS games in an emulator in windowed mode and make screenshots that way; you're still effectively running a Windows app in that situation.

But it sounds as if you've actually built a hardware device that boots into

DOS — I imagine it's running on a Raspberry Pi. The problem is that DOS is a single-task OS. To make a screen grab, you'll need to install something called a TSR (Terminate and Stay Resident), which looks for a hardware interrupt from the keyboard and then dumps the contents of the screen memory to a file. There is a utility at bit.ly/1S5TDWM called Screen Capture v2.01, but it only works on text screens. TSRs were notorious for making programs crash and there's no guarantee you could fit both the TSR and the game into the 640KB of the real mode memory address space that DOS uses. A better idea would be to install a DOS emulator like www.dosbox.com on your desktop and make the screen grabs on that.

Luis Villazon

HARDWARE

TOO HOT OR TOO COLD?

I have a Samsung laptop that's 3 or 4 years old. Recently, it's been randomly shutting itself down. No error message or warning.

I've checked the core temperatures in the BIOS screen immediately afterwards and CPU and graphics are barely above 60°C. When I monitor the temperature while it's still running, this can get to 90°C quite often without any problems — so why does it shut down at just 60°C? I've tried setting the laptop up in the conservatory, which is pretty cold, but it doesn't seem to make any difference. Do you think it's worth renewing the thermal paste on the CPU?

Aidan French

This actually doesn't sound like it's an overheating problem because, as you've

noted, the shutdowns aren't correlated with high temperatures and lowering the ambient temperature makes no difference. This sounds like it's being caused by a loose connection or a dry solder joint. This is the worst possible diagnosis, unfortunately, because it's the hardest to track down and the fix is nearly always a replacement motherboard. Which in a four-year-old machine, is nearly always the same thing as a replacement laptop. We'd try unplugging and reseating the RAM chips first, just in case, but don't be surprised if it doesn't work and you have to get this turns out to be a professional job.

Luis Villazon

LINUX

YOU ARE HERE

What's the Linux command line shortcut for 'the directory you are currently in'?

Martin Oesterhorn

It's the `..` character — which is the same as it is for the Windows command line. In the Linux bash shell, you can also use `~+` or `$PWD` or even `$(pwd)`. We don't think any of these other shortcuts have any particular advantage over the full stop though. Also, you can use `..` to refer to the directory above the current one. This works in Linux and Windows equally.

Luis Villazon

HARDWARE

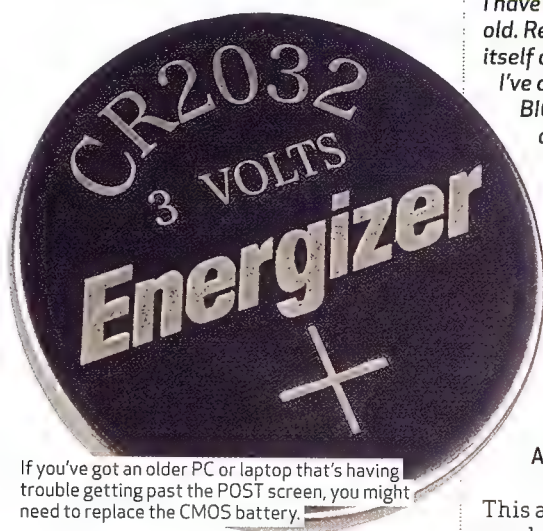
PC WON'T BOOT AFTER RANDOM CRASHES

I've been getting five or six blue-screen errors on a daily basis, so decided to perform a fresh install using my Windows 7 CD. I rebooted to my BIOS and changed the boot order, and then rebooted, only to be presented by a black screen with a white underscore character. No option to enter the BIOS or beep errors, nothing! Can you help?

Jo Swanepoel

We further discovered that Jo had attempted to reset her CMOS by leaving the battery unconnected for 30 minutes, but nothing happened when she did this. She was able to get back into the BIOS by using the CMOS reset jumper, but on restoring defaults, ended up where she started with a blank screen. We advised her to replace the CMOS battery with a fresh one, and check the CMOS pins, which were all straight. She replaced the battery, and after three cycles of restoring the defaults and fiddling about with the CMOS jumper found her PC booted back into Windows again.

Nick Peers ■



If you've got an older PC or laptop that's having trouble getting past the POST screen, you might need to replace the CMOS battery.

Harness the power of properties in VBA

Helen Bradley explains how to make best use of some key VBA form control properties in Excel.

When you add a control to a form in VB and VBA, you can set certain properties for that control. Some properties are object specific and others apply to most, if not all, objects. This month, we'll look at ten properties that can be used to provide a better experience for you as you develop your code and for your audience as they put your solutions to use every day.

HANDY VBA PROPERTIES

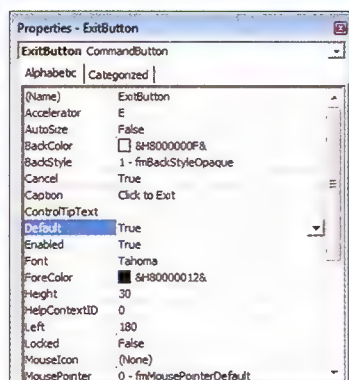
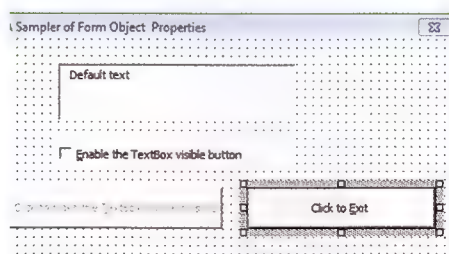
The Caption property controls the text that is displayed on or alongside buttons, checkboxes and other similar objects. If you set a control's Accelerator property to a character used in its Caption text, the user can press Alt-Accelerator to select the control at runtime. For the TextBox control, you set its default text using its Value (or its Text) property.

To disable a control until it is needed, set its Enabled property to 'False' and the control will appear greyed out on the form and it won't respond to any of its events. Similarly, the Visible property makes the control visible or invisible on the form. Whether you use the Visible property or the Enable property to disable a control depends on the context. You would disable a control if you later intend to enable it when circumstances are appropriate for its use. On the other hand, you would hide a control if its appearance makes no sense in the current context.

NAVIGATION PROPERTIES

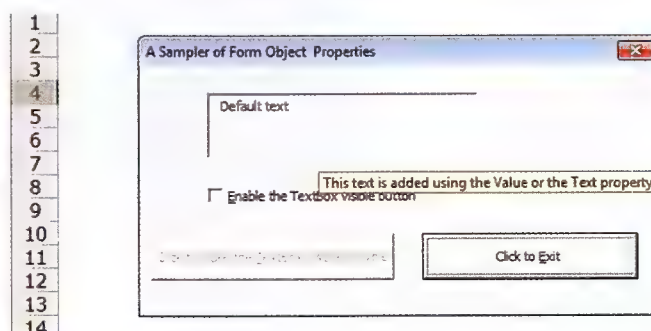
To make a command button operate as a Cancel button, set its Cancel property to 'True'. As only one button can have its Cancel property set to True, this automatically sets the Cancel property on all other controls to False.

To help the user navigate your form, use the TabIndex and TabStop properties. TabIndex sets the order in which controls are visited when the user presses the Tab key. The first control visited has a TabIndex of '0', the next is '1' and so on. Use this property to move your user logically around a form. If the TabStop property is set to 'True', the control will be visited when the user presses the tab key; if it is set to False, the control will be skipped.



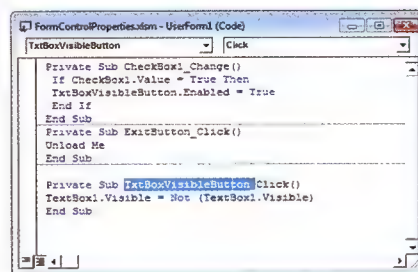
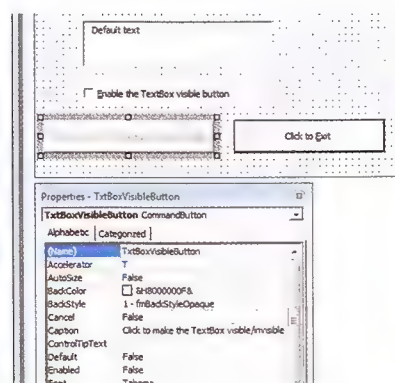
1 STEP 1

To protect a user from making accidental changes, set the Cancel button's Default property and its Cancel property to 'True'. In this way, the Cancel button will be selected by default, so that, if the user launches a form and immediately presses Enter, they will exit immediately without making changes.



2 STEP 2

The ControlTipText property is used to display information to the user when they hover over the control.



3 STEP 3

Every control has a (Name) property, which is how it is referred to in your code. By default, the name is provided by VBA but you can alter this. So setting the (Name) property of CommandButton1 to TextBoxVisibleButton lets you refer to it by this name in your code.

Remove pre-installed apps from Windows 10

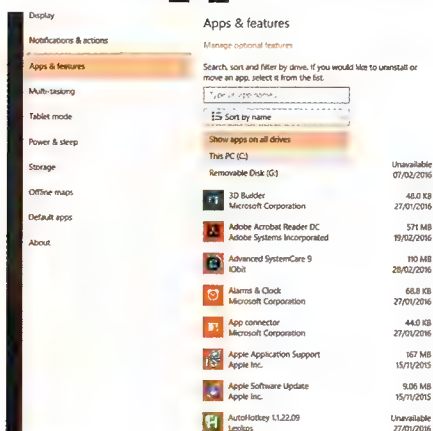
Windows 10 comes with a bunch of app suggestions that you don't really need — Nick Odantzis shows you how to get rid of them.

Microsoft did a wonderful thing when it made Windows 10 available to everyone for free (provided you were upgrading from a machine with Windows 7 or 8).

But as the old saying goes, 'nothing in life is free', and with this gratis version of the OS, you get a few little 'extras' included, but you might not necessarily welcome those additions. For example, there are a variety of pre-installed app suggestions nestled within the Start menu, including Get Office and Candy Crush — just open it up and you'll see them dotted around. Now, some of you might find these suggestions useful, but for those of you who'd rather stop seeing them on your PC, you can easily remove them. You can also stop Windows 10 from delivering the same sort of 'recommendations' in future with just a few clicks.

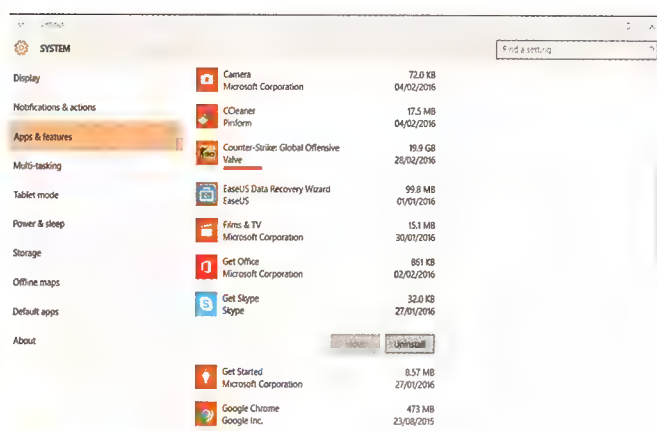


Get apps under control



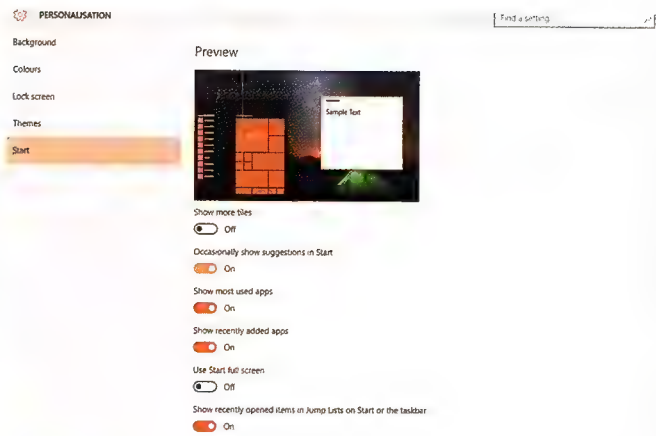
1 GET TO THE SETTINGS

To remove the app recommendations, click on the Start menu, then go to 'Settings' and click 'System'. From here, choose 'Apps and features' from the left-hand menu and you'll see a list of apps on the right side. Using the settings above, you can change the apps — sort by name, size or installation date, look for apps on certain disk drives or just search for the app.

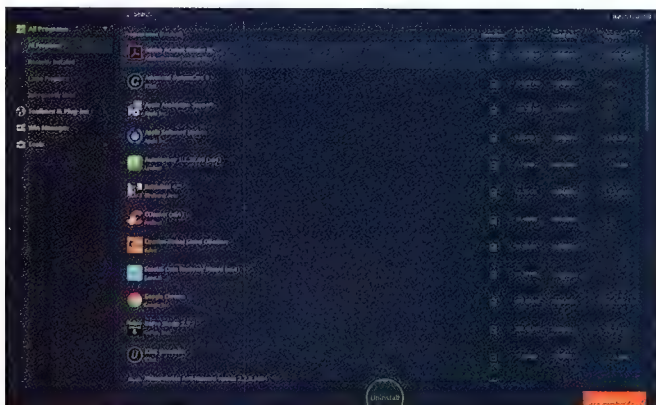


2 FIND THE APP

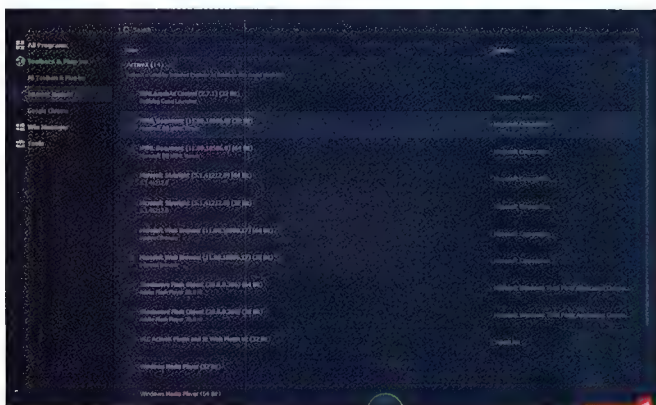
Once you've found the location of the app you want to remove, left-click it to highlight and choose 'Uninstall'. This might take a few seconds depending on the size of the app, but once it's done, head to the Start menu and you'll notice the app you removed is no longer showing in here. You can always put something else more useful in its place.



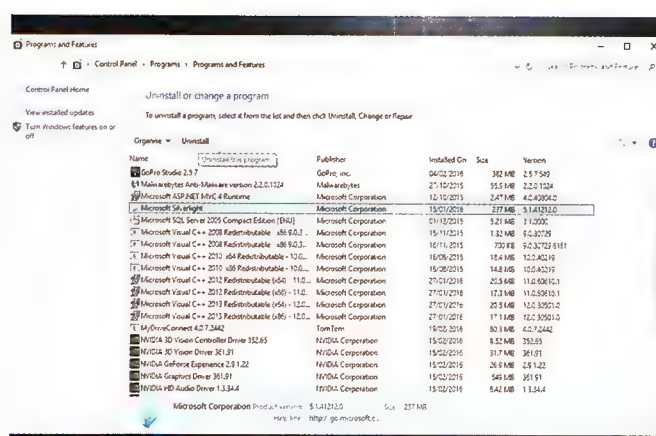
3 PREVENT APP SUGGESTIONS
If you want to stop Windows from recommending particular apps in future, you can disable it — this way, you won't see them in your Start menu. Go to the Start menu and click on 'Settings'. Click on the 'Personalization' heading and hit the 'Start' heading in the left-hand menu. You can now toggle the switch next to 'Occasionally show suggestions in Start' to 'Off'.



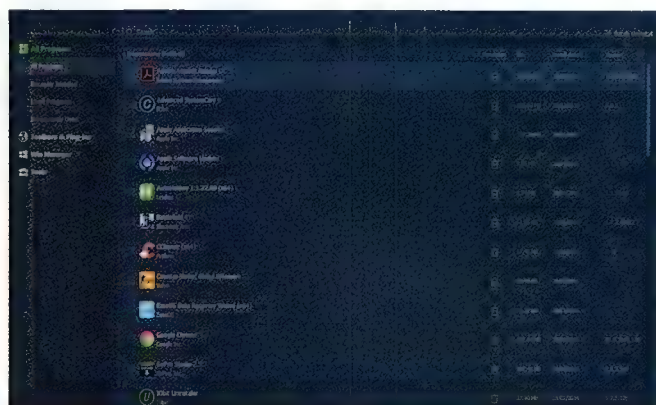
5 A BETTER WAY OF UNINSTALLING
The standard app uninstaller (whether it's the new or old version in Windows 10) is fine. But there's an even better way of uninstalling programs you don't want, and it has even more advanced features. We like IObit Uninstaller (www.iobit.com) — it's a small free download and promises to rid your machine of apps, as well as any fragments they leave behind.



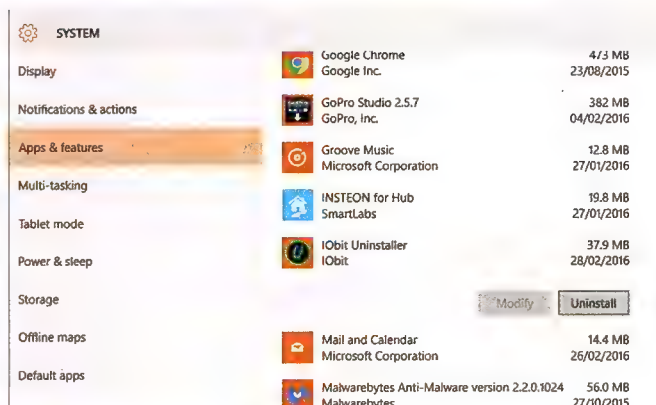
7 REMOVE CHEEKY BARS
You know those toolbars that end up on your machine, even though you don't recall putting them there? Well, IObit Uninstaller can remove those, too. Click on 'Toolbars & Plug-ins' in the left-hand menu and you'll see all toolbars, as well as those within your Internet browser. If you know what the toolbar is called, find it and eradicate it by clicking it and selecting 'Remove'.



4 REMOVING APPS, OLD-SCHOOL
If you want to uninstall apps on your machine just follow the procedure in 'Step 1'. If you prefer the old way of uninstalling apps, right-click the Start menu and choose 'Programs and features' from the menu that appears. Does that look familiar? If so, just click an app and hit the 'Uninstall/Change' button to remove it.



6 A CLEAN SWEEP
Once you've installed IObit Uninstaller, it'll run automatically, showing all the apps installed on your system. You can either remove them one by one, clicking 'Uninstall' on each one (you can create a restore point, just in case you change your mind) or you can remove loads of apps in one go. Tick the checkbox next to 'Batch Uninstall', select the programs and hit 'Uninstall'.



8 FINISH UP
Now that you've followed this guide, you should have the means to remove any kind of app notification, app itself or unwanted toolbar from your system. If you're happy with the way that IObit Uninstaller worked out for you and feel you don't need its services any longer, don't forget — you can even remove that, too!

How to get photos and videos from your iPhone to your Mac

Matthew JC. Powell sorts through some rather unfortunate user-experience problems.

A friend put out a cry for help on Facebook recently: “I just emailed myself some videos from my iPhone, because Apple is too stupid to just let you plug your phone in and save them”. He’d tried using iCloud and he’d tried using Mail Drop and it all just didn’t seem to be working. It should be so simple: plug your phone in and save them. Why is Apple so stupid?

Well, the truth is that Apple isn’t quite that stupid. You can, in fact, plug your iPhone or iPad into your Mac and save photos and videos wherever you want them. The problem is that what happens (usually) when you plug your iPhone into your Mac is kind of stupid, and the sensible straightforward solution is not the default. With a few little tweaks, though, you can get photos and videos from your iOS device in exactly the straightforwards manner you (and the friend above) might prefer.

First, let’s look at what happens when you plug in an iOS device by default if you haven’t changed any settings.

For a start, iTunes will launch and attempt to sync with your phone. This isn’t an entirely bad thing, as it means you’ll have a full, local, disk-based backup of the contents of your device in case anything goes wrong. If you rely on iCloud to back up your device, bear in mind that iCloud backs up “the most important data” – not everything. It’s a good habit to back up your device to a computer every once in a while, even if you do use iCloud backup as well.

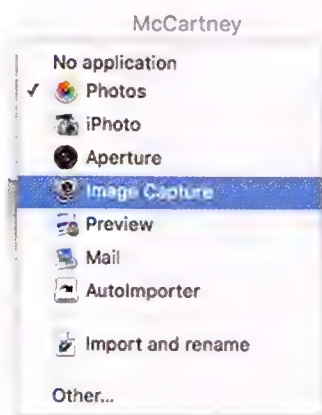
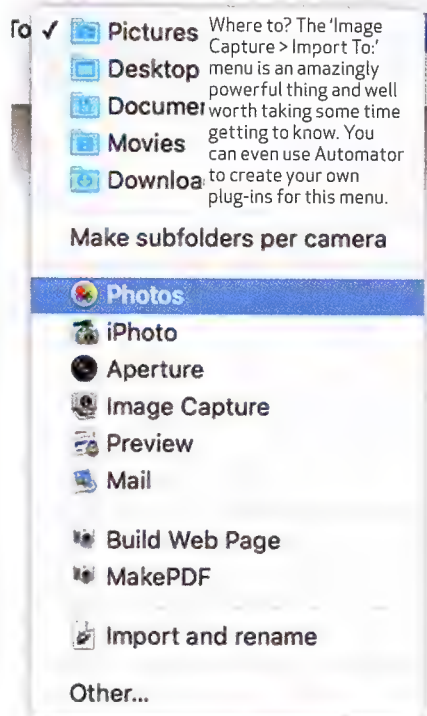
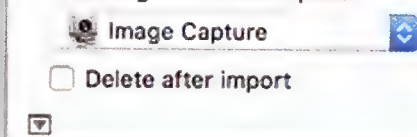
At the same time, Photos will launch and attempt to read your device’s Camera Roll and compare the contents against its library to see if there’s anything new. Again, this is a fine enough thing given the role of Photos as your Mac’s repository of images created by you.

The problem is these two things happening at once. It frankly shouldn’t be possible for two applications on your Mac to attempt to synchronise with the same device at once, but there you go – that is the default behaviour. Like riding a unicycle and solving the



Decisions, decisions. Despite its simple-looking interface, Image Capture packs a lot of power into two drop-down menus.

Connecting this iPhone opens:



This one, thanks. Of all the options you can have open automatically when you plug your iPhone in, Image Capture is the fastest and best at what it does.

Rubik's Cube, it's possible to do these two things at once, but you're unlikely to do both of them well. Most likely neither will be done as elegantly as if they had been done separately.

So the first thing to do is to change the default behaviour. First, connect your device. This may be annoying, as the applications arm wrestle over it for a while, but they'll finish eventually.

Next, go to iTunes and click on the icon for your device in the upper-left area of the iTunes interface. If necessary, also click on Summary in the left-hand column to bring up the main control screen for the attached device.

Next, go to the section headed 'Options'. It may be necessary for you to enlarge the iTunes window or scroll down to find it. At the top of this section is a tick box: 'Automatically sync when this iPhone is connected'. Click to deselect that. You can, of course, still sync manually when you connect your device, but deselecting that option means iTunes won't immediately try to take control.

Next, open Photos. You'll probably find you're already on the Import

screen, with your device pictured in icon form at the top of the window. Next to it is another tick box: 'Open Photos for this device'. Deselect that as well. Sure, it'll be faster once it's not wrestling with iTunes, but we've got a faster and better way still to be seen.

Next, unplug your iPhone. The reason why will be clear shortly.

Open Image Capture from your Mac's Applications folder (or use a Spotlight search to launch it). Once Image Capture has opened, then plug in your iPhone. Had you simply launched iImage Capture without unplugging the phone first, the application would not have found the device because iTunes and Photos still owned it.

Shortly, your iPhone should appear in the left-hand column under Devices, and the main window will fill with thumbnails, filenames and info about the contents of your phone's Camera Roll. Click on the headings at the top of the columns to decide how to sort things – for example, you might like to have the largest files at the top so that they can be removed from your iPhone to clear up space.

In the bottom-left corner of the Image Capture window, you'll see a drop-down menu headed 'Connecting this iPhone opens:' and a list of suitable applications. If you don't see that menu, click on the small reveal arrow at the very bottom of the window and it should appear. Click on that menu and select Image Capture from the list, so that any time you plug your phone in,

this nice quick informative application will launch.

To the right of that drop-down is another, in which you can select an import location for your images. Remember, of course, that you can simply drag individual files straight from the Image Capture window to any location you choose on an ad hoc basis. However, if you want to set up a regular workflow, you can choose an application or a folder in the Finder to which images will be saved.

If you select a Finder location (say, your Pictures folder) then another option appears in this menu: 'Make subfolders per camera'. This is new in El Capitan, and means you can have separate folders for each device you connect – handy if the family has multiple iPhones and iPads.

The other great bonus with using Image Capture instead of Photos to import images from your iPhone is feedback – you have a far better idea of where you're up to with Image Capture, while Photos can often look like it's just hung while importing a large video file.

And if you still want to have your images available in Photos, no problem – just drag and drop. It's actually faster this way than importing directly into Photos. ■

Capture musical ideas on iOS

Apple's Music Memos is a simple way to experiment using your iOS device. Hollin Jones explains.

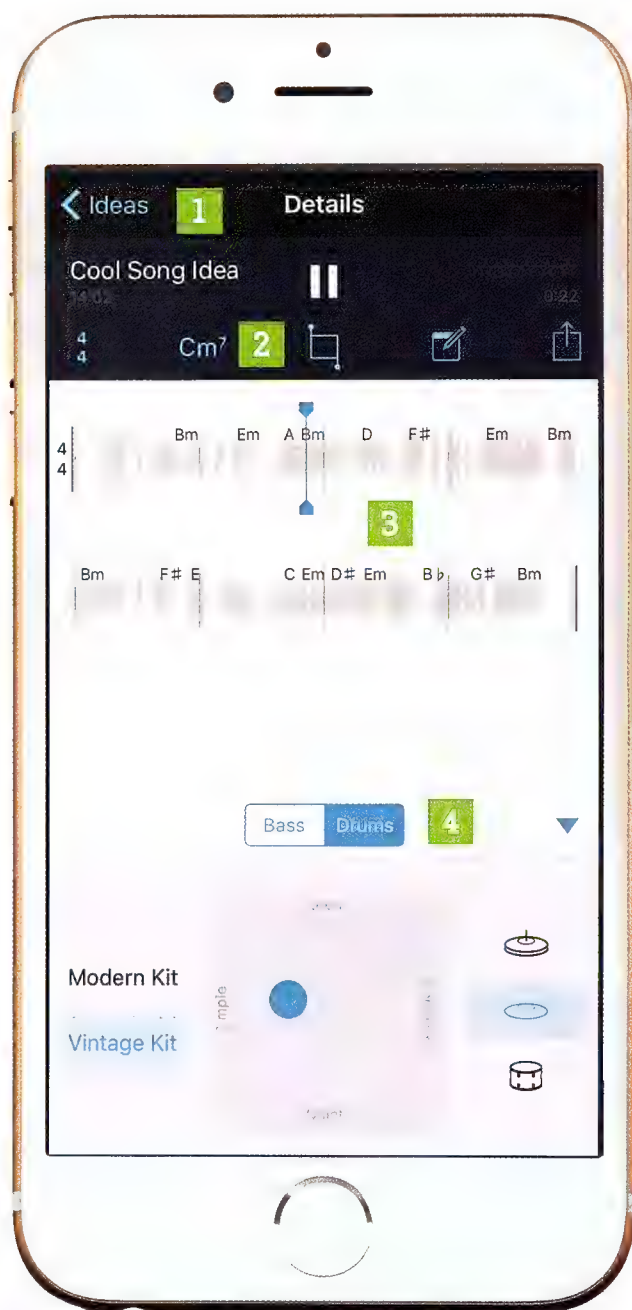
Apple has a good track record of giving away music-making apps for next to nothing, or even entirely free. Its latest audio-focused app, Music Memos, falls into the latter category and runs on any device that supports iOS 9.1 or higher. Of course, recording snippets of sound is nothing new, but this clever tool analyses what you record into it and detects both its tempo and pitch. You can then make some simple edits to your recording and add some backing parts, thanks to technology borrowed from Apple's Logic Pro software on the Mac.

The accompaniment is partly automatic in the sense that Music Memos guesses the pitch and speed information of your recording, be it guitar, piano or vocals, and adds drums and a bass part. Either of those can be switched on or off, depending on whether you want a more stripped-back accompaniment or a fuller sound. The really cool thing is that it adapts even when you change key or if you speed up or slow down a little, thanks to the musical warping technology in action.

For the drums, you can select one of two kits, and also whether the pattern uses open or closed hi-hat cymbals. There are two basses as well, and for either drums or bass, you use an X/Y pad, dragging the dot on the pad along its two axes to make the patterns louder or quieter, and simpler or more complex. It works whatever the duration of your recording, and if the app has guessed wrong, you can go into your recording and select new downbeats to correct the timing of the drums and specify new chords to modify the accompanying bass part into the right key.

FROM RAW IDEA TO SONG

Once you're done, you can add tags to your project for easy searching and export the resulting track either to iCloud or another app, such as iTunes, GarageBand for iOS or Mac, or email it to a friend. Although much simpler than an app like GarageBand, Music Memos is a fantastic way to capture musical ideas on the go when all you might have with you is your guitar and your iPhone or iPad. Being able to add bass and drum accompaniment after recording, rather than needing them first for reference, means you're free to record at the drop of a hat. It's fast, fun and, best of all, free.



1 YOUR IDEAS

Tap this to go back to the list of all your recordings, where you can add names and tags to aid looking up ideas later on.

2 EDITING TOOLS

Use these tools to trim your recording, add a text note and change timing and chord information, and to share ideas with people and other apps.

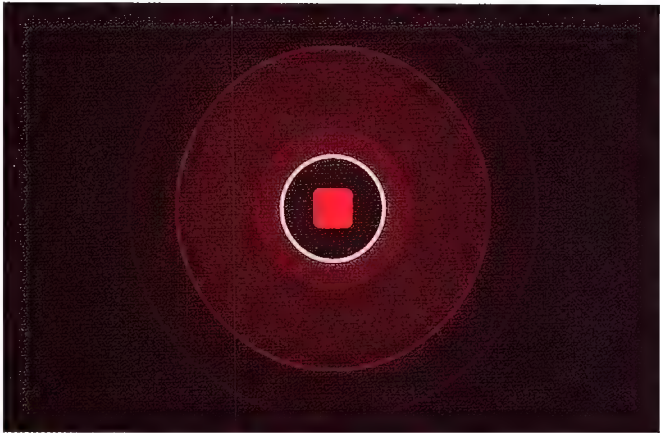
3 YOUR RECORDING

See how the app has detected pitch and timing, and drag the playhead to listen to different sections of your recording.

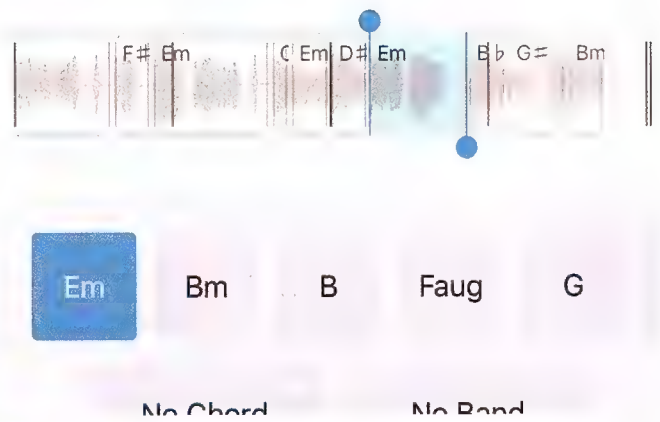
4 RHYTHM SECTION

Tap the bass or drums icons to toggle those parts on or off. Hold a finger on those icons to pick an instrument and set the part's volume and complexity.

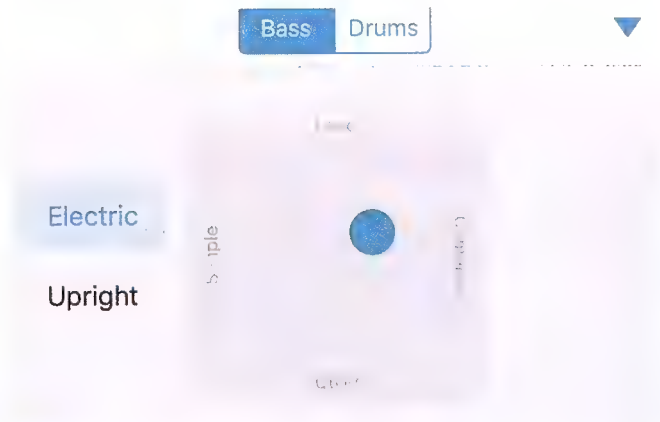
How to use Music Memos



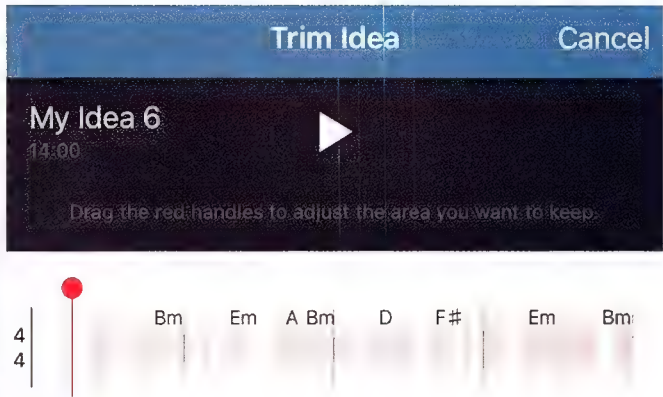
1 MAKE A RECORDING
Open the app and either connect a special iOS-compatible microphone or use the built-in mic with your device. Tap the Record button or tap 'Auto', which records when sound is detected. Play your instrument or sing your melody.



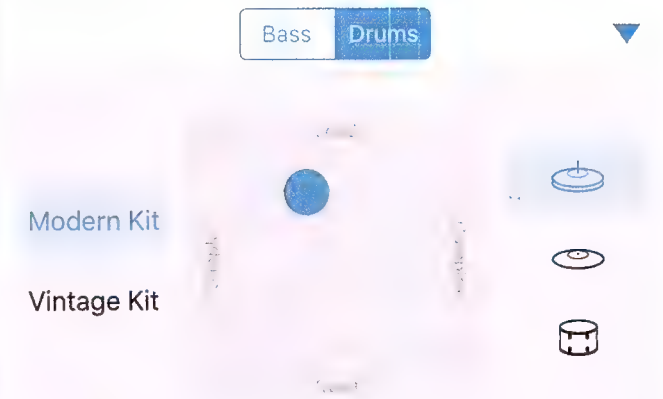
3 CORRECT ANY MISTAKES
If the app has mistaken any chords, tap the 'Chord' button (Cm7), then any segment, and then the correct chord below. This also applies to changing speed using the 'Tempo' button. You can return to do this later, if necessary.



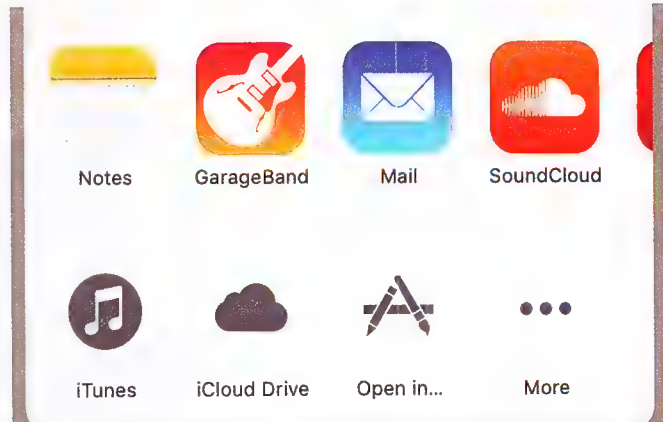
5 ADD SOME BASS
Hold a finger on the bass icon and do the same for that part; you can choose from two instruments, and alter volume and complexity. Using headphones can help, since iOS devices' speakers don't always do bass brilliantly.



2 CHECK THE RESULTS
Tap the Stop button, then play back the idea. Tap the waveform for a detailed view, and drag the blue playhead around the recording. Use the Trim tool (below the Play button) to get rid of dead time at the start or end.



4 ADD SOME DRUMS
Hold a finger on the drums icon to open the rhythm section. To the left of the X/Y pad, pick a modern or a vintage kit, and pick a drum type on the right. During playback, move the dot on the pad to alter volume and complexity.



6 SHARE THE TRACK
When you're happy with the results, tap the Share icon to upload your idea to iCloud, send it to iTunes to develop in GarageBand on your Mac, or to that app's iOS version. You can upload to Soundcloud if its free app is installed.

Fix Ubuntu startup issues

Nick Peers discovers how to resolve issues with non-booting PCs without having to reach for the panic button (or a hammer).

Start-up problems. That moment when – having expected yourself to be getting on with your day's work or entertainment – you find yourself staring at a cryptic error message, or even worse, a blank screen. No matter how many times you press reset or restart, the same impenetrable barrier blocks your path. So what can you do?

Start-up problems come in all shapes and sizes, and they can be difficult to track down. There are, however, some sound principles to use that will resolve many errors, and in this tutorial, we're going to look at the tools and techniques required to troubleshoot most start-up problems. You should start by examining how the boot process works (see 'The Boot process' box opposite). This reveals that the boot process can be split into three broad stages centred around the Grub 2 boot loader: pre-Grub, Grub and post-Grub. Knowing this allows you to focus your troubleshooting efforts based on where in the process the error or freeze occurs.

Let's start at the beginning. You switch on your PC. If power comes on, but nothing else happens, chances are you've got a hardware issue to sort – if you recently poked around the innards of your PC, then check everything is connected correctly. If not, unplug all external devices except your keyboard and try again. If this doesn't work, open the case carefully and disconnect your internal drives too. If the computer now boots to the splash screen, you can try reconnecting the internal drives and trying again; if you're now able to boot to the login screen, shut down your PC and start reconnecting your external peripherals to see if the problem has cleared itself or can be targeted to a single device, in which case try a different cable, or go online and Google for known boot problems involving that device.

If you're lucky, your motherboard will emit a series of beeps or flashing lights you can use – again, by enlisting the help of the Internet – to identify the likely problem. This may involve replacing a component or something more drastic.

If you're able to get as far as your PC's splash screen, but then your computer hangs or a 'missing operating system' error message appears, then first think

back to any recent changes. If you've overclocked your PC, for example, you should now enter the system EFI or BIOS and look for the option to load fail-safe defaults. Then try rebooting again.

If this fails, the problem is likely to be with your hard drive, and so the first places to look are the MBR and Grub. If Grub isn't set to automatically appear when your PC starts, try rebooting while holding the Shift key or tapping Esc to bring up the Grub boot menu to confirm it's not able to even load itself. Jump to the 'Boot-Repair tool' section below once you've verified it's nowhere to be found.

If Grub is able to load, but can't find any bootable OS, you'll find yourself with a number of scenarios: you may be presented with a basic command prompt such as `grub>` or `grub rescue>`, which indicates one or more files required by Grub are missing or corrupt. You may get a specific error message or frozen splash screen, or you may just see Grub and nothing else, indicating it can't even find the most basic information required to proceed.

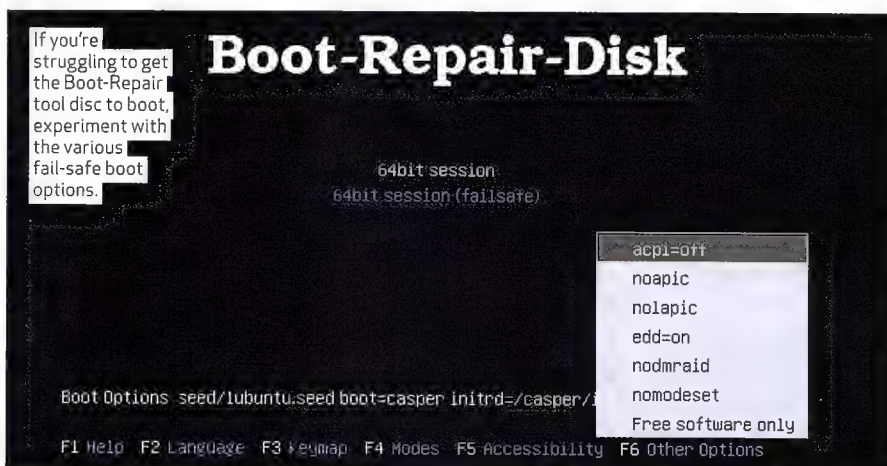
If you press C you may be able to enter the Grub Terminal mode to perform basic checks and repairs – you can attempt to manually initiate the boot by pressing Ctrl-X or F10, for example, or use the `set` command to review current settings and change basic settings such as the graphics mode. Visit bit.ly/Grub2Troubleshooting for a detailed guide to using Grub's own troubleshooting tools, but remember that, in most cases, the simplest fix is



to use the Boot-Repair tool. If the Grub menu appears, then the issue may lie with its configuration file if things immediately grind to a halt after you select a menu option, but if Linux does start loading before grinding to a halt, the problem will lie with your operating system, in which case, skip to the 'Post-Grub troubleshooting' section (over the page).

BOOT-REPAIR TOOL

If you're struggling to fix Grub issues by hand, or there's no sign of Grub on your system at all, then you'll need to enlist the services of your rescue



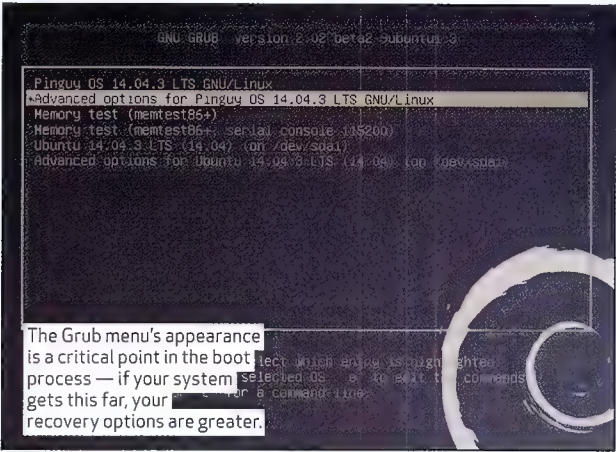
The Boot process

When you press your system's power button, control is initially given to your PC's EFI or BIOS, which starts its various components, performs basic diagnostics tests and attempts to find a bootable device, which is typically the first hard drive. Once located, the BIOS or EFI looks for the Master Boot Record (MBR) at the very beginning of the drive, which has a tiny program inside that loads the next stage of the boot loader, reading a file (such as `e2fs_stage_1_5`), which, in turn, is able to load the Grub boot loader. A 'missing operating system' error at this point means you need your rescue disc for diagnostics as something is missing — either in Grub, the MBR or the drive itself.

Once Grub loads successfully, it reads a file called `menu.lst`, which contains the list of choices you see in the boot menu. Each entry basically identifies the drive, partition and file that contains the Linux kernel, plus RAM disk file used by the kernel as it boots. The entry will also contain any additional parameters passed to the kernel.

Control is now passed to the kernel, which attempts to mount the root file system. This is a key moment, and if it fails, you may get a kernel panic or things might grind to a halt. If successful, it'll create a single process to run the `/sbin/upstart`

file (other distros use `init`) — if this goes wrong, you'll get a panic, it may halt again or drop you into a root shell. At this point, `upstart` starts running scripts and `upstart` events to start other services and eventually bring you to the logon screen.



media and the Boot-Repair tool, which works with all Debian-based distros, including Ubuntu.

The Boot-Repair tool itself will launch automatically when you boot from a Boot-Repair tool disc, but if you're unable to create it, but have access to a Linux installation disc, use that in a live environment instead, then grab the Boot-Repair tool using the following commands:

```
❖ sudo add-apt-repository
ppa:yannubuntu/boot-repair
❖ sudo apt-get update
❖ sudo apt-get install boot-
repair
❖ boot-repair
```

The Boot-Repair tool is focused on those early boot problems caused by the hard drive's boot sector, MBR and Grub. It basically provides a convenient and user-friendly graphical front-end to the tools required to fix many problems. The tool offers a

'Recommended repair' option that promises to fix most frequent problems, or you can click 'Advanced options' to see what it can do and manually select specific fixes without getting your hands dirty in the Terminal. The step-by-step guide (see Tweak Boot-Repair tool Settings over the page) reveals what repairs and tweaks are possible, but note the tool is context-sensitive, and some options may be greyed out or missing depending on your setup.

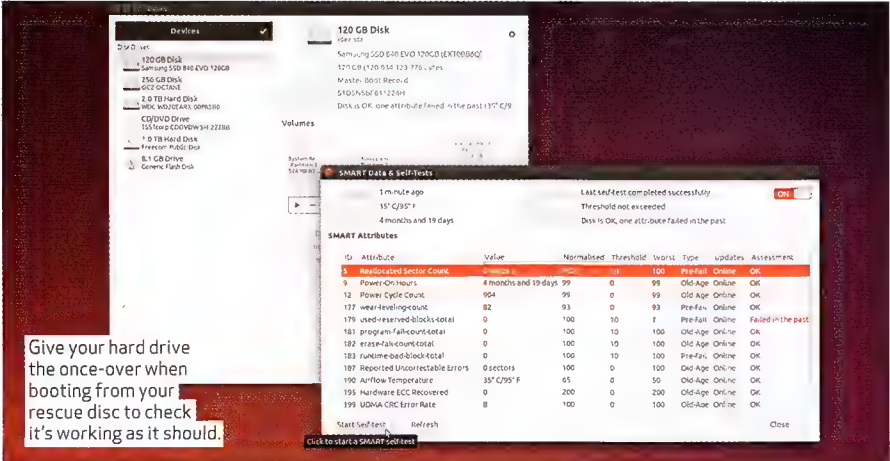
The tool automatically generates a log of your system and what it attempts to do, which you can then share on the Ubuntu user forums if necessary. Before attempting any advanced tweaks on your own, it pays to try the recommended option first, then ask for help on the forums using the output logs generated — this will ensure you choose the right option and don't cause more damage.

NON-GRUB BOOT ISSUES

Your rescue disc will also come in handy should you not even get as far as Grub loading. Once booted, verify the existence and state of your hard drive. Open the file manager and see if your partitions are visible and if you can access the files on them — this is a good time to back up any precious files before you proceed further.

If nothing shows up, check whether the hard drive has been detected by opening the Disks utility from your Ubuntu Live CD — if you're using a Boot-Repair tool CD, you'll need to install the `gnome-disk-utility` through the Synaptic Package Manager under System Tools. Once installed, open it via the Accessibility menu. The Disks tool lists all physically attached drives — if yours isn't visible, you may find the drive has failed, in which case you'll be reaching for your latest backup after shelling out for a drive replacement, or starting again from scratch with a fresh Ubuntu installation and newfound love of backing up your system. Assuming your drive does show up, select it from the left-hand menu where you can examine the partition table plus check its physical health via its SMART attributes. Don't panic unless the drive is deemed on its last legs, but do focus your next check on the partitions themselves. If you run the Boot-Repair tool, its recommended settings will include a full disk check, but you can manually perform this check yourself using GParted, which is on both rescue discs.

GParted enables you to see how your partitions are arranged, as well as revealing which one is the boot.



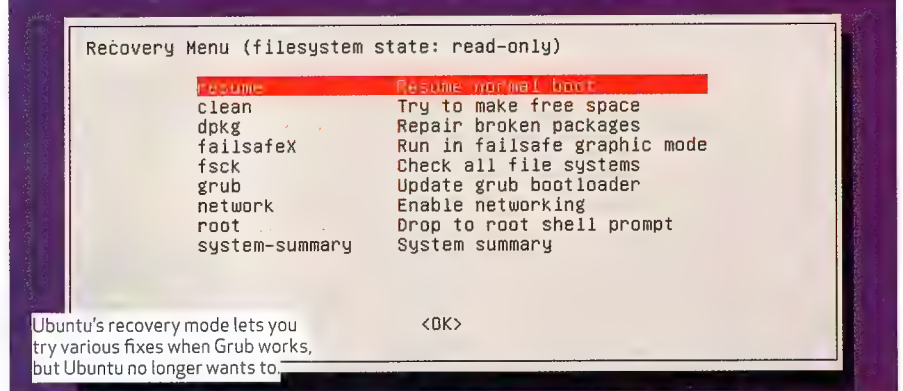
Right-click this and verify 'Mount' is greyed out before choosing 'Check to schedule a disk check using the fsck tool'. This will check for and attempt to repair any problems it finds as soon as you click 'Apply', but it's important the partition isn't mounted before the check is run. Also give it as long as it needs to complete — this could take hours or even days in some extreme cases, and cancelling or aborting will almost certainly corrupt the partition. Make sure the check is run on all partitions on the boot drive.

In most cases, assuming the drive isn't physically damaged or corrupt beyond repair, running these tests should ensure you're able to at least get Grub working again.

POST-GRUB TROUBLESHOOTING

If you find that Grub appears to be working fine, but your problems begin when you attempt to load Linux itself. Try switching to verbose mode during boot by pressing the Esc key to see if any clues appear in the messages that scroll past (or if it hangs at a certain point). Make a note of these and do a search online for them for more advice. If this doesn't happen, hold Shift at boot to bring up the Grub menu if necessary, then select 'Advanced options' followed by '(recovery mode)', which will launch Ubuntu in a minimal state, plus mount the file system in read-only mode. If this is successful, after a succession of scrolling messages, you should find yourself presented with the Recovery Menu, offering nine options.

The options are all pretty much self-explanatory — the 'clean' option may be of use if your hard drive is full, which can cause boot problems. If your problems started because a package failed to install properly, then 'dpkg'



will repair it and hopefully get things working again.

The 'failsafeX' option is a useful if you find yourself booting to a black screen or the graphical desktop doesn't appear to be working correctly — it basically bypasses problems with your graphics drivers or X server to give you a failsafe graphics mode to troubleshoot your problem from.

We've touched on 'fsck' already — this will check the drive for corrupt files, which can clear many errors, particularly if your PC crashed and has failed to boot since. The 'grub' option isn't relevant unless you've used Grub's own recovery tools in place of the Boot-Repair tool to get this far in the boot process — selecting this will make your changes permanent.

Use the 'network' option to re-enable networking, and the 'root' option to drop to the shell prompt, allowing you to troubleshoot directly from there. Be sure to mount the file system in read/write mode using the following command: `mount -o remount,rw /`

You can also pass temporary kernel parameters to Ubuntu during the boot process, which may help in some

scenarios. With your chosen operating system selected in Grub, press the E key to edit the kernel file. Scroll down to the line beginning `linux` — parameters are added to the end of this line after `quiet splash`. You'll need to make sure that you leave a space between each parameter. Once done, press Ctrl-X to boot with those parameters.

Note that any parameters you add here are temporary — in other words, they're removed the next time you boot, so you can experiment until you find a solution that works, then — if necessary — make it permanent by editing the Grub configuration file (`sudo nano /etc/default/grub`).

You can also pass parameters from the live CD environment using the Boot-Repair tool using the 'Add a kernel option', which includes 15 common parameters that can help with troubleshooting. Examples of these include 'acpi=off', which disables the ACPI system that's known to cause random reboots or system freezes on certain PCs, and 'nomodeset', which instructs Ubuntu to only load graphics drivers after the X environment has

Take a fail-safe backup

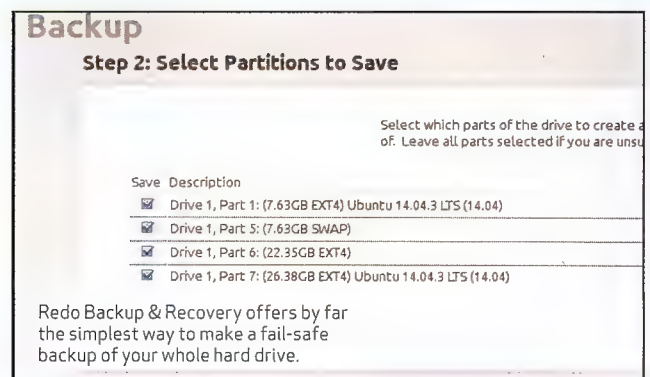
It may seem strange, but if you're struggling with start-up issues, you should attempt to take a backup of your hard drive before you perform any repairs. This means, if you mess things up completely, you can always roll back your system to the state it was in when the start-up problem first manifested itself.

Of course, if you're diligent and you back up your system regularly, you could always simply roll things back now to a working state, although bear in mind there may be data loss involved if your home folder is on the same partition as your Linux installation (as is the case with default Ubuntu installs).

You'll need a suitable backup device — typically a USB-connected hard drive — and a tool that takes a complete drive image of your system. The 'dd' command-line tool can be used from both Ubuntu and Boot Repair Tool live CD environments, but the backup drive needs to be at least the same size, preferably bigger, than the drive you're copying.

At the other end of the complexity scale is Redo Backup & Recovery. You'll need a blank CD or DVD to burn its 261MB ISO

file to, but it provides an easy-to-follow graphical UI. You'll find it at www.redobackup.org.



been loaded, and not before. These temporary parameters can be passed to your rescue disc too, in case you're having problems getting that working. Press F6 at the initial boot screen to choose from the options on show.

For more information on specific parameters, do an online search for the parameter or visit bit.ly/KernelParametersList for a complete list.

REPAIR/INSTALL

There's one last thing you can try from the Grub boot menu — if your kernel has been upgraded, it's possible to boot using an older version of the kernel from the Advanced options screen under Grub. You'll see each version of the kernel listed — try the previous version if you believe your boot

problem is linked to the latest kernel. If this works, you can make the version you've used permanent by editing the Grub configuration file — the simplest way to do this is by using the Boot-Repair tool.

If things look particularly bleak, then you may have luck reinstalling Ubuntu over the top of itself. Boot from the Ubuntu Live CD and choose the option to 'Install Ubuntu' when prompted. When you get to the 'Installation type' screen, you'll be presented with a new option, pre-selected by default: 'Reinstall Ubuntu...'

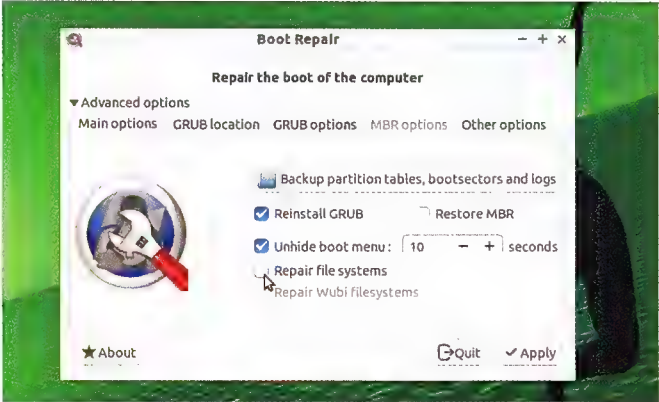
This option basically reinstalls Ubuntu without touching your **home** folder or partition, which means not only should your documents and other files be preserved, but key settings

and many programs may be left alone too. It'll also leave entries in your boot menu alone, ensuring you won't lose access to other operating systems.

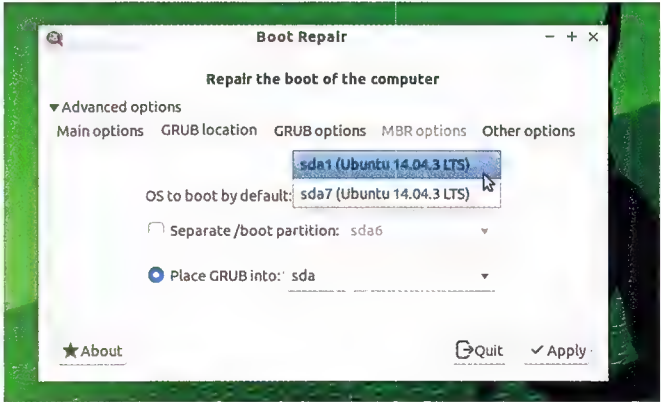
What will be replaced are system-wide files, which will hopefully root out any corrupt ones and get your PC up and running again. Although it doesn't affect your files, it's still good practice to back up the drive — or at least your home folder or partition — before you begin.

To ensure you don't lose anything from your system, make sure you recreate all user accounts with the same login and password, including, of course, your own during the install process.

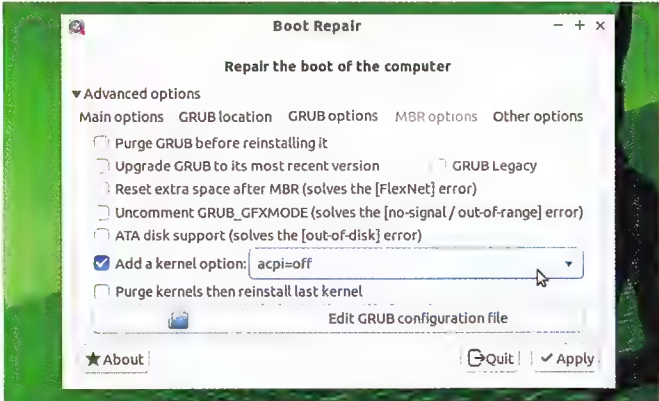
Tweak Boot-Repair tool settings



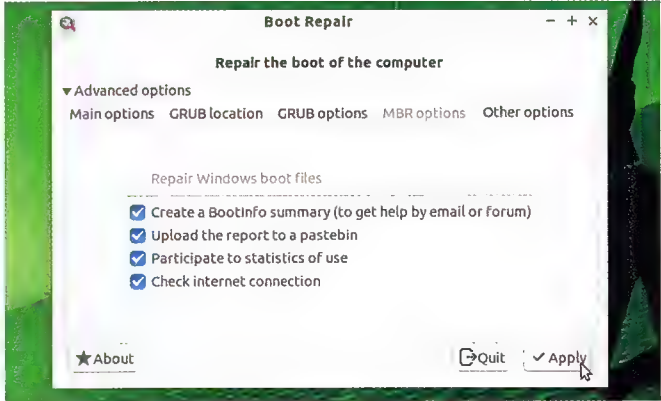
1 MAIN OPTIONS
The first tab offers a convenient button for backing up your current partition table, boot sector and log — click this to copy this key information. It's also where you can reinstall Grub, restore the MBR and choose whether to hide the Grub menu. If you think your filesystem is corrupt, tick 'Repair file systems' to have it checked and fixed.



2 GRUB LOCATION
This tab allows you to specify which OS to boot by default in a multi-boot setup. You can also choose to place Grub in its own separate **/boot** partition if you wish — typically, this is only needed on encrypted disks, drives with LVM set up or some older PCs. The final option specifies which drive Grub itself will be placed (**sda** by default).



3 GRUB OPTIONS
This section opens with options for making sure Grub is updated to its latest version. There's also three specific error fixes offered. You can also add new kernel options to the Grub menu here, or purge all previous kernels before reinstalling the last one. You may even see an option allowing you to edit the Grub configuration file directly.



4 OTHER TWEAKS
If the MBR options tab isn't greyed out, use it to restore your MBR from a backup and choose which partition gets booted from it. The final Other options tab offers an opportunity for repairing Windows files (irrelevant in most cases) and provides options for pasting a summary of your settings online for reference. ■

Train your Raspberry Pi to report its own status

Play God and make your Raspberry Pi self-aware with Mayank Sharma.

Do you use your Raspberry Pi for a headless project, such as a media player, NAS server, seed box, or security camera? If you do, then your Pi's probably tucked out of the way somewhere that's not particularly easy to access. You can always log in to it remotely but how do you monitor it in real time? How do you know whether it's overheating? Or running out of disk space? In this project, we're going to give your Raspberry Pi the ability to communicate with you.

REGISTER AN XMPP ACCOUNT

We need to install the `sendxmpp` tool on the Raspberry Pi [Image A], which allows it to communicate via the popular XMPP messaging protocol. We will use this to send notifications to us via instant messages whenever a predetermined event is triggered. First up, you'll need to get an XMPP IM account for the Pi. If you aren't using an XMPP server already, you can register with any of the publicly listed XMPP servers (xmpp.net/directory.php). We're using the jabber.hot-chilli.net service, which gets a top-notch security rating from xmpp.net, and allows you to register an account on the website itself. Once you've registered an account for your Raspberry Pi, make sure you add it as a friend on your regular IM account, on which you want to receive notifications.

INSTALL SENDXMPP

Now log in to the Pi, update the repos, and then download the `sendxmpp` tool with:

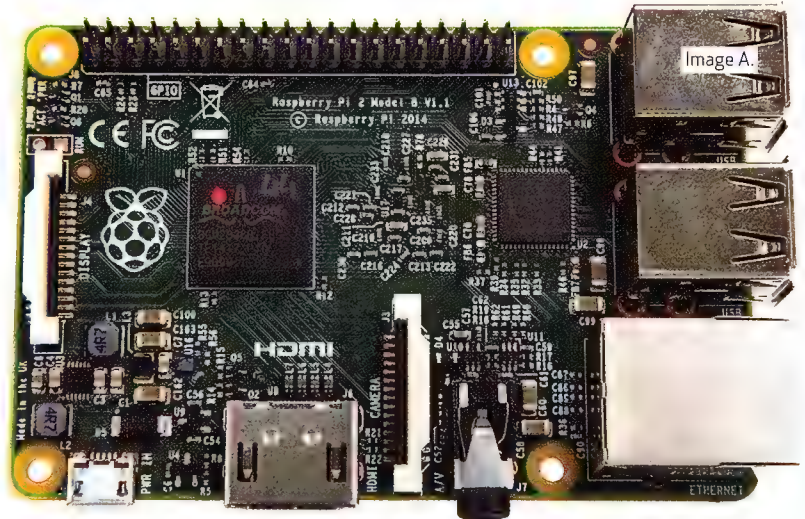
```
sudo apt-get install  
sendxmpp
```

It's a Perl script and it will pull in the required Perl dependencies. When it's installed, create a file named `sendxmpprc` under your home directory with the credentials of the Pi's XMPP account, such as:

```
$ nano ~/.sendxmpprc  
rpibot@jabber.hot-chilli.net  
my-secret-password
```

Remember to replace the username and password with the credentials for the account you registered for the Pi. After saving the file, you can send a message with:

```
$ echo "Hi, this is Pi!" |
```



```
sendxmpp -t geekybodhi@jabber.  
hot-chilli.net
```

The above command sends a message from the Pi to the XMPP ID specified with the `-t` option. Swap out the ID in the example above with your own XMPP ID. If you're signed in to your regular IM account, you'll receive the greeting as a regular message from the Pi's XMPP account.

You can also pass output of Bash commands, such as:

```
$ echo "It is" $(date) |  
sendxmpp -t geekybodhi@jabber.  
hot-chilli.net
```

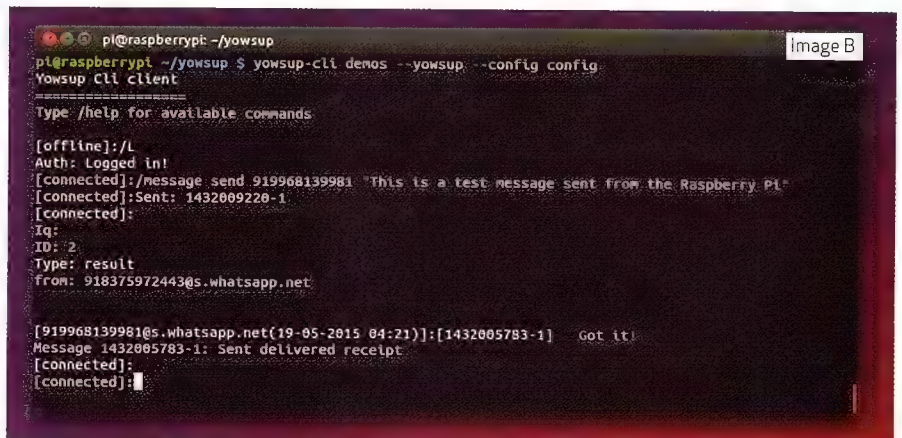
This command sends the output of the `date` command. Here's another example that's a bit more useful:

```
$ echo $(/opt/vc/bin/  
vcgencmd measure_temp) |  
sendxmpp -t geekybodhi@  
jabber.hot-chilli.net
```

This command queries the temperature sensors on the Pi using the utilities installed by the `raspberrypi-firmware-tools` package, which we then pipe to our regular IM user. You can use this statement to monitor the Pi and send you an alert over IM when the temperature crosses a preset threshold. Copy the contents of Listing 1 (see page 99), or nab it from pastebin.com/NdQw5ftr in a file called `status.sh`. Then set a crontab entry by running `crontab -e` and entering the following line:

```
*/5 * * * * ~/status.sh
```

Here, we are asking the Pi to run the `status.sh` script every five minutes. Remember to change the location of the `status.sh` file to the location on your Pi. So what's in the `status.sh` script? The script stores the temperature of the Pi in a variable



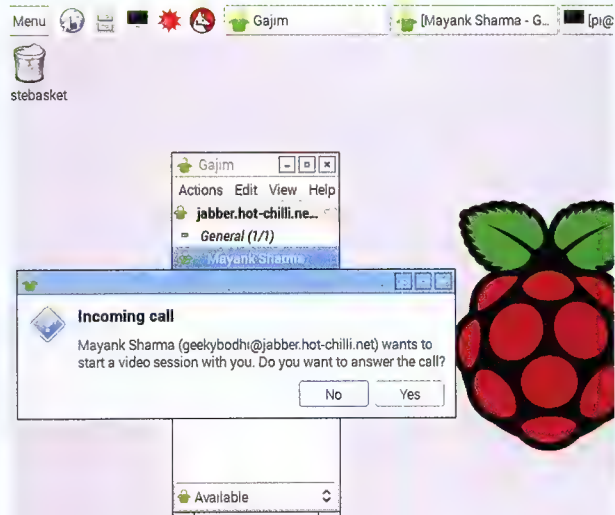
Video chats

If you're using the Raspberry Pi 2 as a regular desktop, you can install an IM client and converse with your friends either via text or video. The XMPP protocol we've discussed in this tutorial is one of the most popular ones for exchanging instant messages, and is used by services such as Google Chat.

One of the best XMPP clients for the Raspberry Pi, with the right balance of size and features, is Gajim. It's available in the official Raspbian repos, and you can install it with a simple command:

```
sudo apt-get install gajim
```

Once installed, you can hook it up to your XMPP account and exchange text messages with your friends. You can also hook up a webcam to the Pi and make video calls to your buddies. But for that, you'll first have to make sure you've got the `gststreamer1.0-plugins-bad` and `python-farstream` packages. Both are available in the official Raspbian repos, and can be installed with the APT package manager. Once you have installed the webcam and the required components, your chat window now features a button that enables you to start a video session. If you have trouble transmitting audio or video, head to 'Edit > Preferences > Audio/Video' and make sure you're using the correct audio output device. If you're on a limited connection, you can reduce the video size by picking a lower resolution from the 'Video Size' menu.



named 'temp', after stripping out the verbose text and the decimal, because Bash can only handle integers. The script then checks whether the value is greater than 40°C, and if it is, alerts us with a message. You can extend this script to keep track of the goings-on in the Raspberry Pi. For example, you can ask it to send you alerts whenever it finds a particular message in a log file, or whenever the status of a daemon changes. The `sendxmpp` script helps you keep track of the activities on the Pi – however, you can't act on them without logging in to the Pi. But what if this isn't possible? What if you get a temperature warning from the Pi monitoring your home while you're away at work? Wouldn't it be great if you could control the Raspberry Pi via messages as well?

YOUR BEST BUDDY

WhatsApp is one of the most popular messaging apps, and you can use it with the Pi. The Yowsup Python library [Image B] enables you to use your WhatsApp account to exchange messages with your contacts. After the novelty of messaging your friends from the Pi wears off, you can use the Yowsup library to monitor and control the Pi by sending messages via WhatsApp.

Before you can install the Yowsup library, you should fetch its dependencies with:

```
# sudo apt-get install git
python-dev libncurses5-dev
Then use:
# git clone git://github.
```

```
com/tgalal/yowsup.git
...to download the library under the
current directory, and install it with:
# cd yowsup
# sudo python setup.py
install
```

Once the library is installed, it's time to register your mobile number with WhatsApp. In the 'yowsup' directory, create a file called "mydetails" with the following:

```
# nano mydetails
cc=1
phone=17712345678
```

The "cc" option points to the country code, which is 1 in the United States. Replace it and the phone number with your particulars. Make sure you don't enter the '+' symbol. Then save the file and use the following to ask WhatsApp for a registration code:

```
# python yowsup-cli
registration --config
mydetails
--requestcode sms
```

ENTER YOUR CODE

After a few seconds, you should receive an SMS on the phone with the SIM card for the number you have entered in the mydetails file. The message contains a six-digit code. Use this code to register your cell number with WhatsApp:

```
# python yowsup-cli
registration --config
mydetails
--register xxx-xxx
```

Replace "xxx-xxx" with your code. After a second or two, you'll receive a response from WhatsApp on the Pi, which will look something like this:

```
status: ok
kind: free
pw:
jK0zdPJ9zz0BBC3CwmnLqmxuhBk=
price: 0.99
price_expiration: 1434674993
currency: USD
cost: 0.99
expiration: 1463544490
login: 448375972334
type: new
```

The only bit of information we're interested in is the password mentioned with the "pw" variable. Copy it and paste it in the mydetails file, which should now read:

```
cc=1
phone=17712345678
password=jK0zdPJ9zz0M8G3Cwm
nLqmxuhBk=
```

That's all there's to it. The Yowsup library includes a demo application, which you can use to send and receive messages. Bring it up with:

```
# yowsup-cli demos --yowsup
--config mydetails
```

This brings up the Yowsup command-line client. Type "/help" to see all the available commands. The '[offline]' prompt indicates that you aren't connected to the WhatsApp servers, so use the '/L' command, which picks up the authentication information from the 'mydetails' file and connects to the server. The prompt now changes to '[connected]'. You can now send messages to other WhatsApp users. To send a message to 19988776655, for instance, enter:

```
/message send 19988776655
"Hiya mate, I'm sending this
```


how » raspberry pi masterclass

from the Raspberry Pi!"

If the recipient responds with a message, it is displayed on the console on the Raspberry Pi. To end the session, use the '/disconnect' command to quit.

WHAT'S UP, PI?

Of course, the real advantage of the Yowsup library is that it can be used to invoke various useful actions on the Raspberry Pi. For example, you can send a WhatsApp message to check certain details on the Pi, such as its

free disk space or temperature, then maybe update it or shut it down. You can also use it to influence the GPIO pins, and control any connected peripherals – a door, for example.

You can use the Python script in Listing 1 (opposite) to interact with the Pi. The script listens to messages from a certain predefined number, recognises certain keywords, and responds accordingly. So if you send something such as "Hiya, Pi," it greets you back. If it receives a message that

begins with "memory", the Pi executes the 'df -h' command, and messages you the results.

The script uses classes created by Italian blogger Carlo Mascellani. They are housed with two files, named 'wasend.py' and 'warecieve.py', which you can download by entering:

```
# wget http://www.mascal.it/public/wasend.py
# wget http://www.mascal.it/public/warecieve.py
```

In the same directory, create a file called "pitalk.py" with the contents of Listing 2 (opposite). Now create a shell script called "talktome.sh" that calls the pitalk.py Python script:

```
# nano talktome.sh
```

```
#!/bin/bash
while :
do
sudo python /home/pi/
yowsup/pitalk.py
done
```

EXECUTE THE SCRIPT

Now make it executable with "chmod +x talktome.sh" and make sure it runs automatically whenever the Pi boots up by pointing to it in the /etc/rc.local file:

```
# sudo nano /etc/rc.local
/home/pi/yowsup/talktome.sh
```

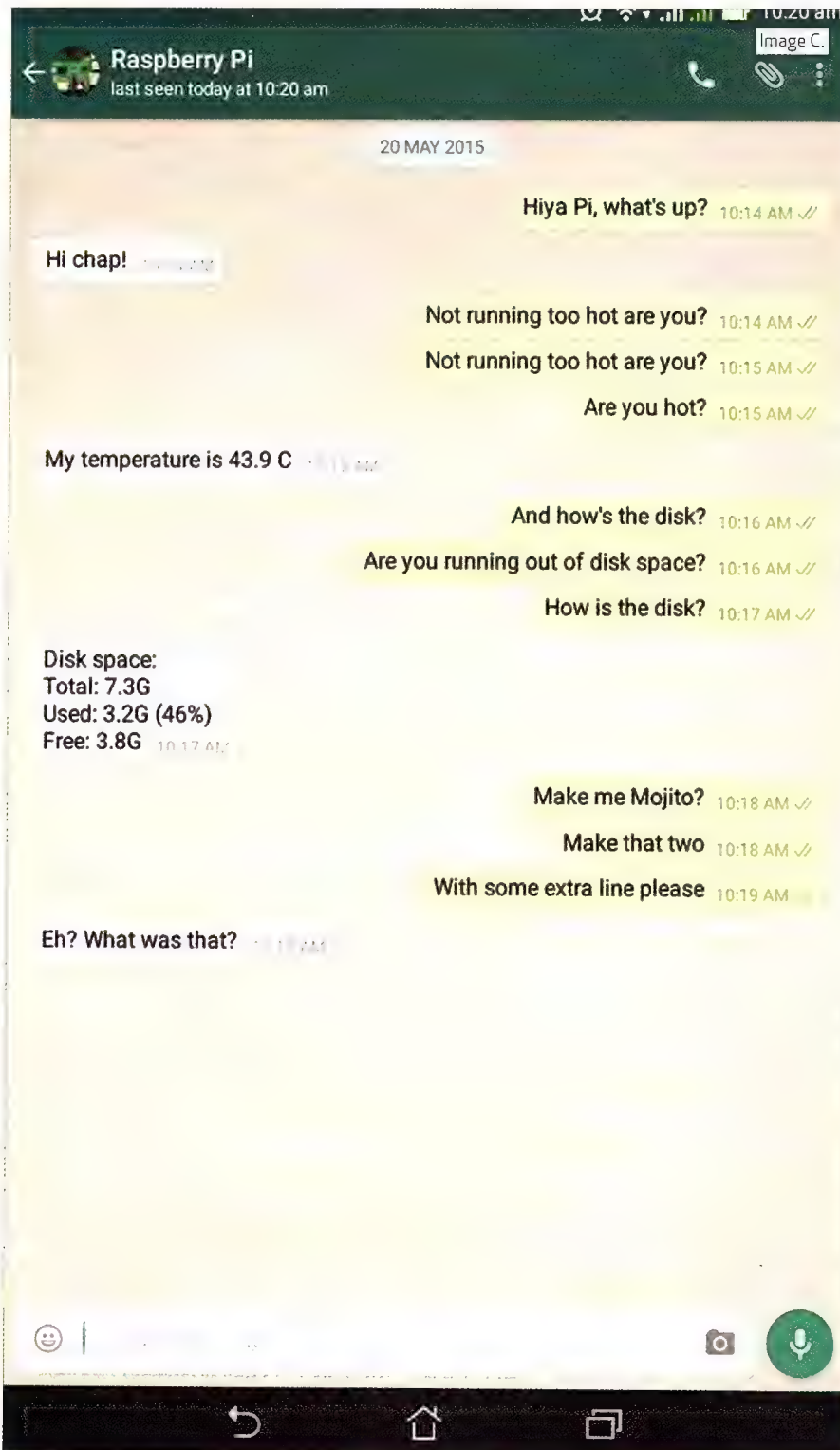
Save the file and reboot the Raspberry Pi, and the script starts automatically.

PARSING THE SCRIPT

Let's break down the script to understand it better. The 'credential()' function at the top helps connect the script to the WhatsApp server by using the credentials for your account. Make sure you edit both the parameters in this function. The 'Answer()' function specifies the WhatsApp number our Pi communicates with. This is important, because we don't want just anybody to control our Raspberry Pi.

Then we define the functions that do the actual tasks we query the Pi for via the WhatsApp messages – for example, the 'Refresh()' function refreshes the repository list, and 'Restart()' reboots the Pi. The 'Temp()' and 'Disk()' functions are a little more complex. The former fetches and truncates the temperature information, as illustrated earlier in the tutorial. Similarly, 'Disk()' formats and rearranges the output of the 'df -h' command for easier reading.

In the main part of the program (the 'while' loop), the script waits for a message, and when it gets one, it raises a 'MessageReceived' exception. The received message begins with a phone number followed by a message, such as '19876543210Message'.



GOING FURTHER

When it raises the exception, the script first converts the whole string to lowercase with the `'value.lower()'` method. It then checks whether the message is from the number it's supposed to respond to. If it isn't, the script appends it to a log file and doesn't respond.

If, however, the phone number is correct, the script then strips the number from the message and just leaves the textual bit. The `'if'` conditions then parse the message to decide how to respond.

We've used different types of matching to give you an idea of what's possible. The first two look for matching characters at the start of

the text – for example, `"if received[:4]=="hiya": Answer("Hi chap!")` is triggered if the first four characters of the message are `'h', 'i', 'y'` and `'a'`, and responds with `"Hi chap!"`. This condition is met even if the message it receives is, `"Hiya Raspberry Pi, are you online?"`. The second also looks for matching characters at the beginning of the message, but is triggered if it finds either of the two strings `"restart"` or `"reboot"`.

The next three do a different kind of matching. They're triggered if their corresponding text is in any part of the message and not just at the beginning. So if you send a `"What's the status of your disk?"` message (Image C), the script picks up the `"disk"` keyword and

triggers the `'Disk()'` function. Similarly, if you send a `"You're not running too hot, are you?"` message, the script picks up the `"hot"` keyword, and responds with a readout from its temperature sensor. If it fails to pick up any keywords, the script just responds with the `"Eh? What was that?"` message.

You can extend this script for a variety of home automation tasks. You can even hook up the Pi camera module and use the Python Picam library to take pictures or videos, and send them to you via a WhatsApp message.

Check the Yowsup library's wiki page (github.com/tgalal/yowsup/wiki) for some examples of rolling the script into usable applications.

Listings

In this tutorial, we use two scripts, which you can download from pastebin.com/NdQw5ft.

LISTING 1: STATUS.SH

```
#!/bin/bash
temp=$(/opt/vc/bin/vcgencmd measure_temp
| cut -cb-7)

if [ "$temp" -gt 40 ]; then
    echo Whoa! My temperature is up to $(/
opt/vc/bin/
vcgencmd measure_temp). Power me down for a
bit! |
sendxmpp -t geekybodhi@jabber.hot-chilli.net
fi
```

LISTING 2: PITALK.PY

```
import os, subprocess, yowsup, logging

from wasend import YowsupSendStack
from wareceive import YowsupReceiveStack,
MessageReceived

def credential():
    return

"17712345678","jK0zdPJ9zz0BBc3CwmnLqmxuhBk="

def Answer(risp):
    try:
        stack=YowsupSendStack(credential(),
[["17668139981",
risp]])
        stack.start()
    except: pass
    return

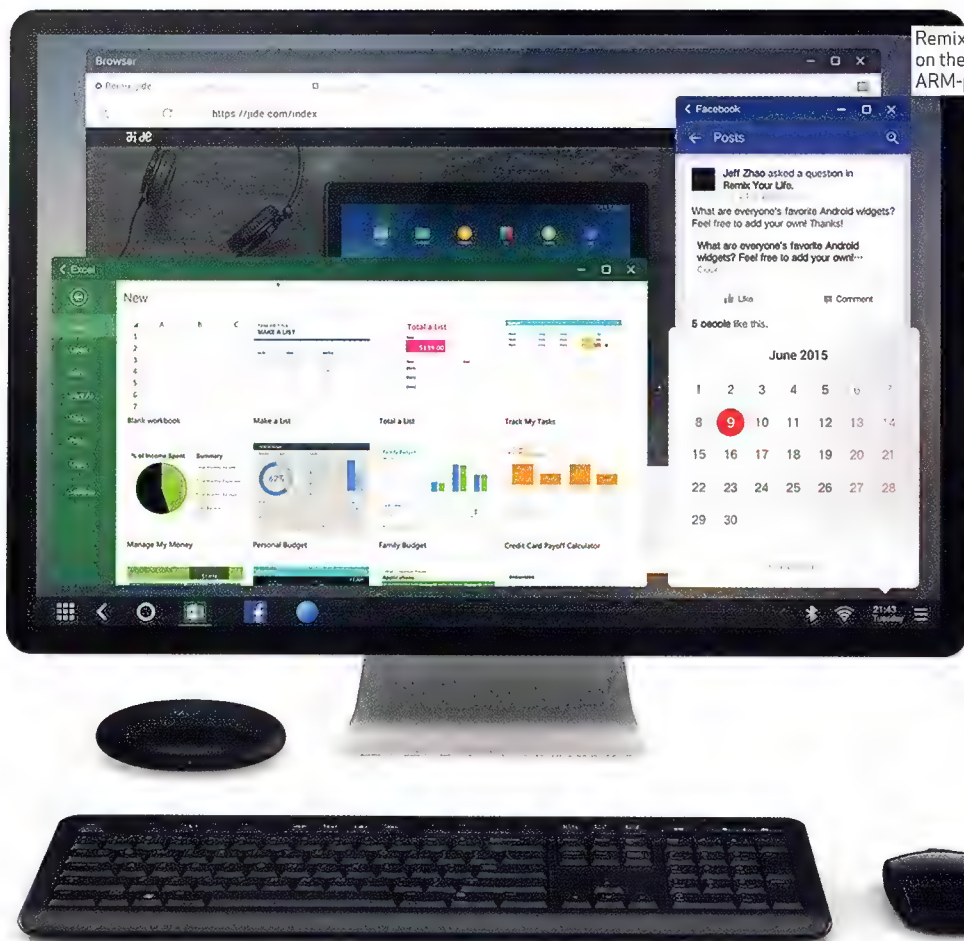
def Refresh():
    Answer("Refreshing the repos.")
    os.system("sudo apt-get -y update")
    Answer("Repos updated.")
    return

def Restart():
    Answer("Rebooting")
```

```
os.system("sudo reboot")
return

def Temp():
    t=float(subprocess.check_output(["/opt/
vc/bin/vcgencmd
measure_temp | cut -cb-9"], shell=True)
[:-1])
    ts=str(t)
    Answer("My temperature is "+ts+" C")
    return

def Disk():
    result=subprocess.check_output("df -h
.", shell=True)
    output=result.split()
    Answer("Disk space:\nTotal:
"+output[8]+" \nUsed:
"+output[9]+" (" +output[11]+" )\nFree:
"+output[10])
    return
    while True:
        try:
            stack=YowsupReceiveStack(credential())
            stack.start()
        except MessageReceived as rcvd:
            received=rcvd.value.lower()
            if received[:1]
en("17668139981")==="17668139981":
                received=received[1]
en("17668139981"):
                    if received[:4]=="hiya":
                        Answer("Hi chap!")
                        elif received[:7]=="restart" or
received[:6]=="reboot":
                            Restart()
                            elif "disk" in received: Disk()
                            elif "hot" in received: Temp()
                            elif "refresh" in received: Refresh()
                            else: Answer("Eh? What was
that?")
                        else: #message from wrong sender
                            with open("/home/pi/
whatsapp.log","a") as mf:
                                mf.write("Unauthorized access from:
"+received[:len("17668139981")]+\n")
```

Remix OS is also available on the Remix Mini, an ARM-powered mini-PC.

Run Android as your full-time desktop OS

The push for Android on PC-grade hardware gains momentum with new Remix OS and Phoenix OS adding multi-window desktop support. Darren Yates reports.

Over the last couple of years, we've been keeping tabs on Android-x86, the open-source project bringing various iterations of Android to Intel-based x86-PC hardware. Built on Google's Android Open Source Project (AOSP) code, Android-x86 is hitting its straps to such an extent that you're more likely to get Android 6.0/Marshmallow running on PC hardware than you are on all but the most recent smartphones and tablets.

Android-x86 is available in multiple flavours from 4.0/Ice Cream Sandwich to 4.4/KitKat, 5.1/Lollipop and now 6.0/Marshmallow, all free of charge and available from android-x86.org. And as we showed you in our March issue, you

can install it on real PC hardware or run it as a virtual machine on your existing Windows PC via VMware Workstation Player or Oracle VirtualBox hypervisors.

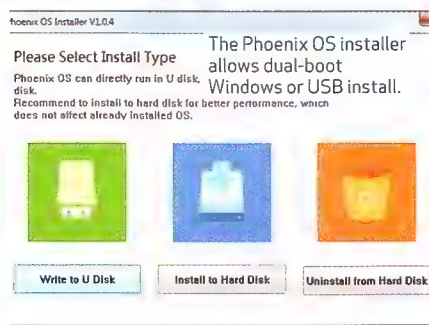
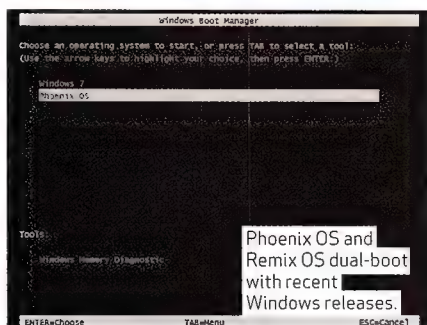
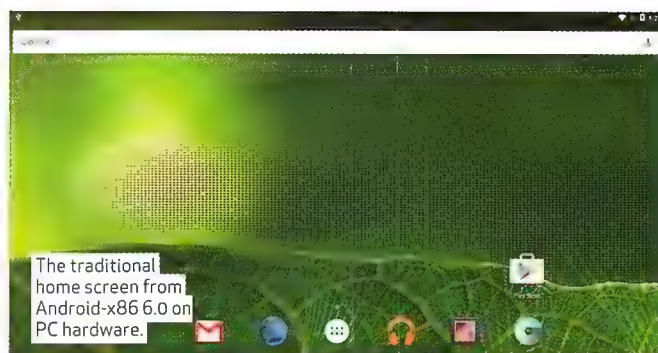
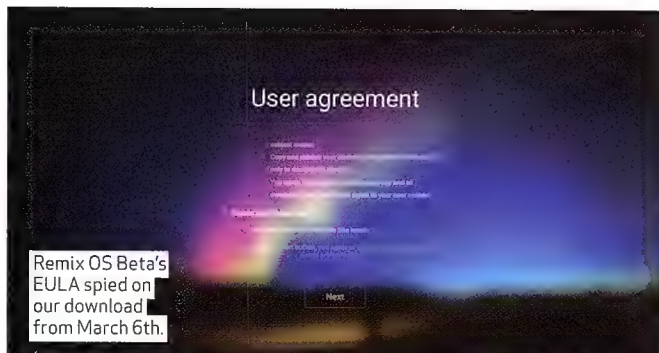
But in recent weeks, we've seen two revolutionary new commercial forks of Android-x86 arrive with the potential to turn the PC market on its head.

POTENTIAL GALORE

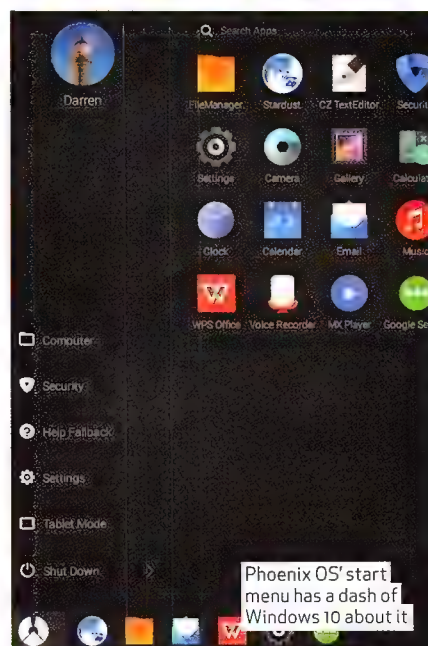
These new releases, 'Phoenix OS' and 'Remix OS', are both built on Android-x86's version of 5.1.1/Lollipop, but add in a desktop window manager, allowing genuine multitasking with Android apps as resizable windows on the desktop.

Now, if you're thinking this sounds a lot like Chrome OS, it's not quite the same thing. In fact, this is potentially much better. Yes, Google released App Runtime for Chrome (ARC) to enable Android apps to run on Chrome OS, but this is native-Android – well, as close to 'native' as x86 hardware will allow. That should mean less fiddling around getting more apps to work. Both of these new desktop Android variants also allow traditional full-screen app mode, giving you the best of both options.

However, the reality is they are still works-in-progress and not without issues, but we've given each a run this month and definitely recommend you keep an eye on these projects over the



"Now, if you're thinking this sounds a lot like Chrome OS, it's not quite the same thing. In fact, this is potentially much better!"



next year. The potential for desktop Android is huge.

REMIX OS BETA

Chinese-based Jide Technology was founded by three ex-Google engineers (Jeremy Chau, Ben Luk and David Ko) in 2014 and announced the first developer-focused alpha of 'Remix OS for PC' in January this year. The first public beta followed on March 1st.

It's available as a Torrent or download from the Remix OS website (www.jide.com/en/remixos), which you can install onto a hard drive or USB flash drive, but not in the usual 'live Linux distro' sense. Remix OS comes as a zip package with text file instructions, a 2.64GB ISO image and Remix OS Installation Tool. However, unlike most Linux distros, Remix OS doesn't allow standalone installation onto a fresh disk partition — you have to use the Installation Tool and create a virtual dual-boot setup within Windows 7, 8 or 10 (similar to Ubuntu's old WUBI setup), or you install it onto a USB drive.

Depending on your work preferences, the USB install option could be more useful as it creates a genuine portable install, with its own

built-in persistent storage for file saves.

EULA CONTROVERSY

However, the original Remix OS alpha caused a stir when users began examining its End User License Agreement (EULA) more closely. Unusually, the EULA pops up on first-boot and one clause that set forums alight stated 'you agree that you irrevocably waive any and all ownership, legal and moral rights to your user content' (imgur.com/a/MhIUU).

After copping flack online, Jide Technology reportedly came out with a statement in mid-January, saying the EULA was a standard Chinese agreement copied into the international release and that Jide's legal team had removed the user content and moral rights language for future versions (youtu.be/jihuNbb6uHk).

The explanation soothed some users, but we were surprised to see the same clause appear in the 'B2016030106' 64-bit beta we downloaded on March 6th (see our screenshot). Needless to say, requiring your users to hand over all ownership rights to their content isn't a great look and we hope Jide fixes this in a hurry.

That said, we still gave Remix OS a run and here's what you need to know.

HOW TO INSTALL IT

STEP 1 — First, grab the Remix OS zip file from www.jide.com/en/remixos-for-pc and unzip it to a folder in your PC. The zip file includes the ISO image, .txt file instructions and the Remix OS Installation Tool. It'll allow you to install Remix OS as a dual-boot OS on existing Windows 7, 8 or 10 system drives or, alternatively, to a USB flash drive for use as a 'live' drive. Choose the latter option and Jide recommends a USB3.0-class flash drive with at least 8GB of storage and 20MB/second write speed.

Given this is beta software, we'd also recommend using a spare PC for this and not a mission-critical production system, just in case things go pear-shaped.

STEP 2 — Launch the Remix OS Installation Tool and follow the steps provided. Rather than making a WUBI-like dual-boot setup, we chose the simpler USB flash drive install option to see how it performed. Obviously, make sure you have backed up any important files as the flash drive will be erased during the install

process. Further, make sure you also select the drive carefully. This Installation Tool can install Remix OS to your Windows system drive and while Jide says it can be removed by launching the UninstallRemixOS.exe file inside the RemixOS folder on your PC drive, just be sure you know what you're doing before doing it.

Once installed to a USB drive, you'll only see any empty folder under Windows Explorer. While it looks like a custom version of the popular UNetbootin ISO image tool, the Installation Tool actually creates three partitions on your USB flash drive – one for Remix OS, a second empty 3GB partition and a third, providing FAT32 filesystem storage using whatever space is left over. The Installation Tool creates these partitions, but Windows Explorer only sees the FAT32 storage block.

STEP 3 – Next, install the USB flash drive into a test PC, boot into the BIOS and set it to boot first from the USB drive. Reboot and you should see the launch menu appear on screen. There are two options – Guest Mode, which doesn't save any changes (all changes are lost on reboot) and Resident Mode, which does allow changes to be saved.

This is where things slow down a touch. The first boot in any Android system is always comparatively slow, but you'll need a pretty fast flash drive not be left hanging here for a few minutes. Eventually, though, you'll come up to the initial language choice.

HOW IT LOOKS

When it finally appears, Remix OS has the usual things you'd expect to see in a desktop OS – right-click context menus, start menu, desktop launch icons, taskbar, even pop-out right-side notification panel. In fact, squint and Remix OS has a bit of a Windows 10 look about it (okay, so you have to squint hard). But the novel thing about Remix OS is being able to view your favourite Android apps in multiple resizable windows rather than just one full-screen.

SIDELOAD GOOGLE SERVICES

Limiting Remix OS installation to virtual dual-boot and USB live drive options only is a drawback, but more of an issue is the lack of Google Services, which, among other things, means no Google Play app. The good news is the fix just requires you to install a single .apk package file. Point your Remix OS browser to Google Groups at tinyurl.com/gq9fqyo, download the GMSActivator.apk file and launch it.

You'll first need to set the OS to allow app installation from unknown sources (go to Settings > Security), but after that, it should install. Launch the app, click the Download Google Services button and, within a couple of minutes, it should download and install the Google Play Services and Google Play apps into the OS. Once done, you'll need to reboot the PC for it to take effect, but after that, you should have Google Play in the Start menu, ready to

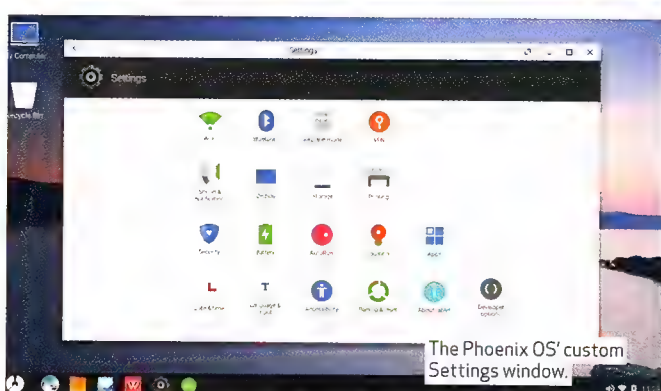
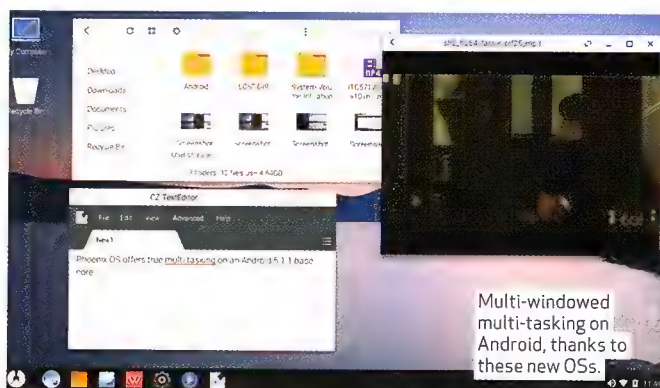
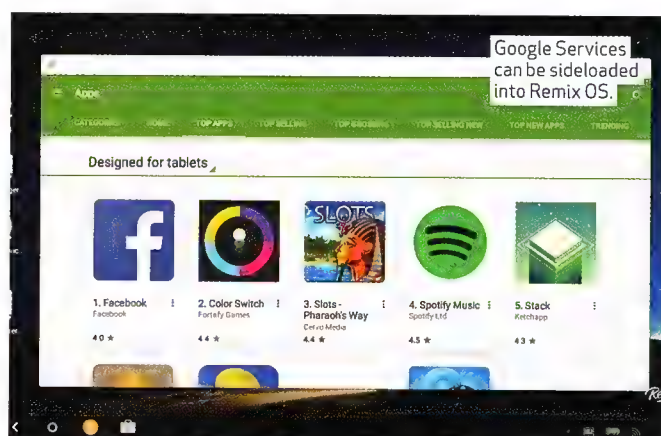
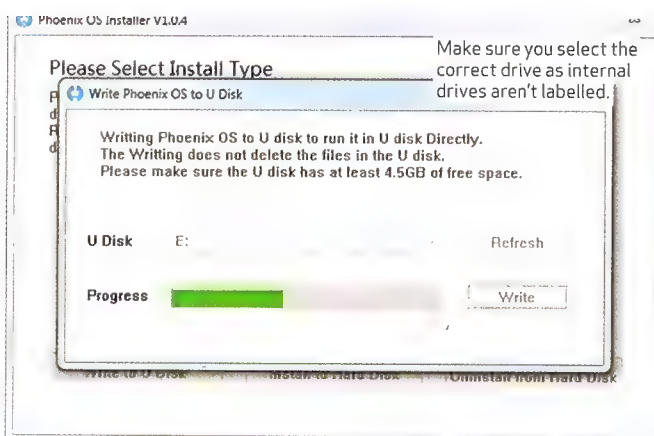
load in your login details and start downloading apps. (Obviously, however, this does mean that it won't work in Guest Mode.)

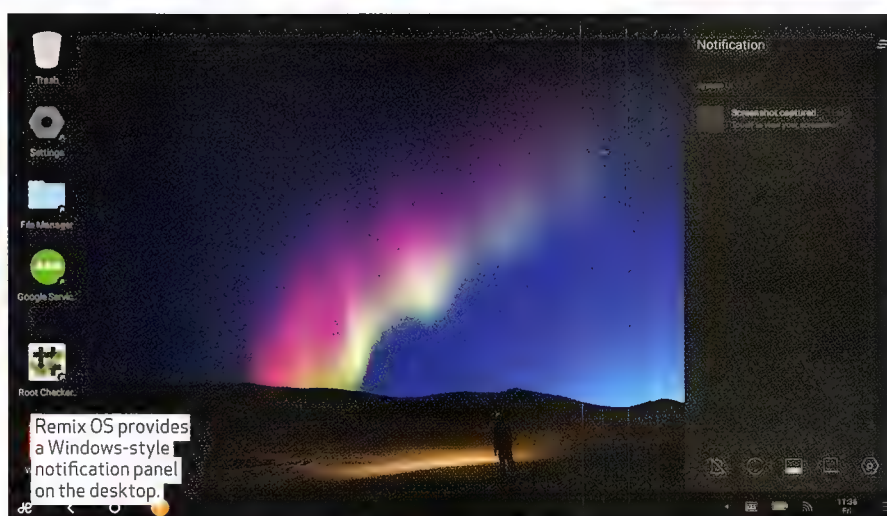
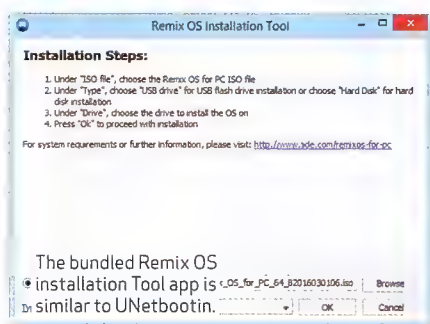
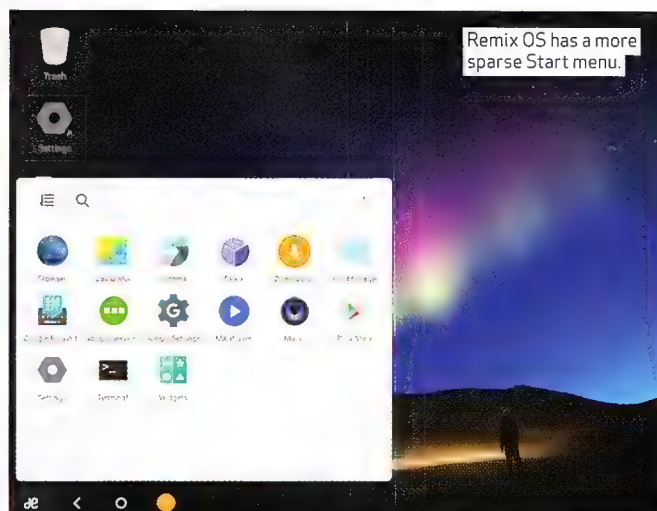
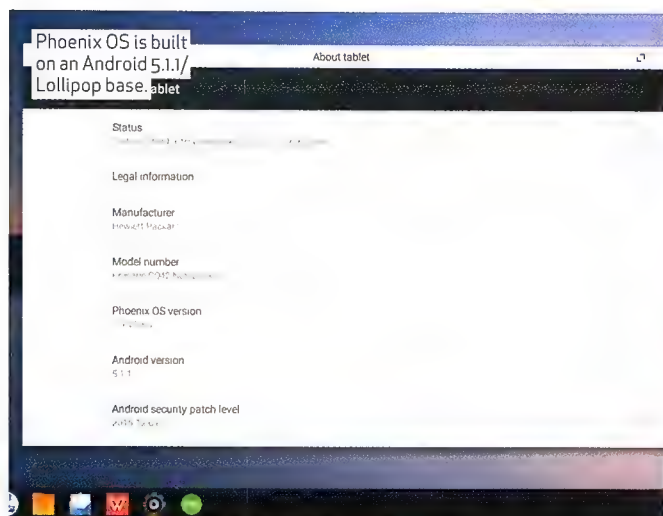
USB PARTITION ISSUES

Another potential issue appears if you decide Remix OS isn't for you and you want your USB flash drive back. The problem is that Windows can't handle multiple partitions on USB flash drives – Windows Explorer can't see them and Disk Management can't do anything with them. The only way to get rid of them on a Windows system is to use the Diskpart command-line tool, but you'll need to use it with care – it doesn't enumerate drives by letter, so you'll need to know the capacity of each disk in your system in order to select the correct one. It's fairly easy to use, but keep a sharp eye because it's all too easy to accidentally delete another partition instead and end up killing system storage or, worse, your PC.

PHOENIX OS

Remix OS isn't the only show in town, with rival Phoenix OS having popped up around the same time. It's another Chinese release available free-of-charge, this time created by Beijing Chaozhuo Technology Co. The website isn't quite as slick as Remix OS, but overall, Phoenix OS has a good feel about it. We downloaded the current (at time of writing) v1.04 installer from www.phoenixos.com/en/download_x86.





It's about half the size of Remix OS beta, and while it has its own unique install process app (the download is a single .exe file), it still gives you more or less the same options as Remix OS; namely, install to a USB flash drive or virtual dual-boot to an existing Windows setup. However, it lacks Remix OS's temporary Guest Mode option and you must use the Installer Tool to remove the dual-boot. It's also missing Google Services but, unfortunately, the GMSActivator.apk installer that fixes this on Remix OS failed here.

What's interesting is that the USB installation setup here is completely different to Remix OS. Whereas Remix OS creates multiple partitions on your USB flash drive, Phoenix OS needs only one partition, appearing to keep persistent storage in a virtual disk file.

On the up-side, the desktop layout, particularly the Start menu, feels more comfortable and has even more of a Windows 10 feel about it than Remix OS. It's also leaner and seems faster than Remix OS on USB2.0-era hardware (definitely on USB drives). The drawback for now at least is the lack of Google Services. Still, it has WPS Office and MX Player already on-board and we had no trouble playing H.264 video from a second USB flash drive.

The main problem is we know nothing about Beijing Chaozhuo Technology Co, so we can't recommend

you start loading in your Google login details into this one just yet. If you have a test Google account, give that a go instead.

WHICH TO CHOOSE?

There's plenty of movement happening in 'desktop Android' at the moment, but as we've said, realistically, it is work-in-progress-grade stuff. That means they all have benefits and drawbacks.

We think Remix OS's EULA needs work and we'd like to see that fixed, but being able to at least sideload Google Services sweetens the pot nicely. Phoenix OS looks great, runs well, but lacks Google Services support for the moment, even as a sideload on our testing and is a bit of an unknown quantity at this stage. Vanilla Android-x86 offers the greatest versatility of installation, but gives you only the standard Android experience on your PC hardware — no multi-window multitasking.

We think things have also been complicated recently by Android-x86 founder Chih-Wei Huang's decision to partner up with Jide Technology. In the recent announcement, Huang said Jide could help push Android-x86 along,

but also stated the Android-x86 project "will continue to be an independent open-source project" (android-x86.org). Nevertheless, Android-x86 is now gaining some serious momentum and it'll be very interesting to see how it progresses over 2016.

In the meantime, getting off the fence, my tip for the moment would be to go with Android-x86 4.4-r5 — it's the most recent update and likely the most stable x86 build. The fact you can install it as a standalone OS without dual-booting and run it on a hypervisor are pluses in my book.

But it's also very likely Remix OS and Phoenix OS will offer better device driver support, given the apparent effort to make them into genuine desktop OSes. Rather than narrow your options, keep an eye on both of these new desktop Android releases as well.

It's still only early days, for sure, but a genuine Android desktop operating system could seriously become a thing of beauty. ■

Play WAV files with an Arduino Nano

Following on from last month's digital audio recorder, Darren Yates turns an Arduino Nano 3.0 into a compact digital audio player.

Getting an Arduino to play digital audio is always fun because these little 8-bit microcontroller boards were never designed for it. In last month's digital audio recorder project, we tricked up the low-speed analog-to-digital converter (ADC) inside the Arduino MEGA2560 chip to record 8-bit WAV files at up to 48kHz sample rate. However, none of these 8-bit Arduino boards have the digital-to-analog converter (DAC) circuitry to play digital audio.

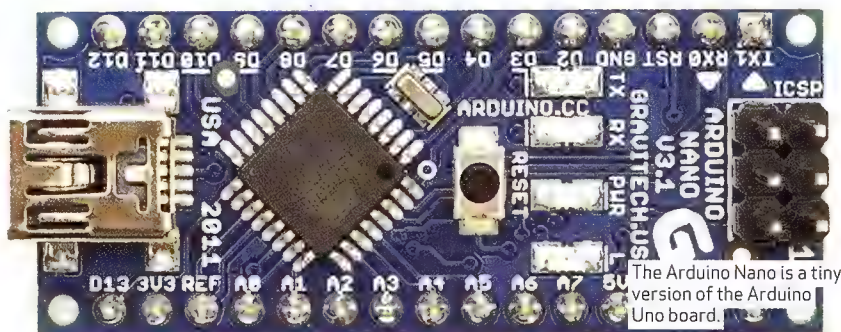
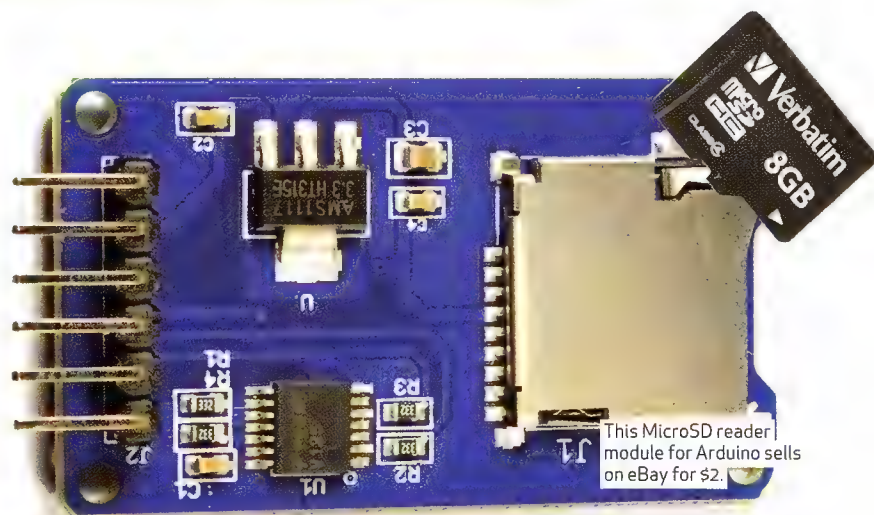
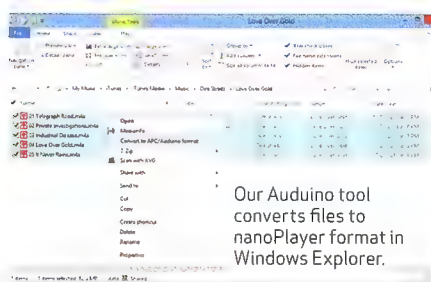
Nevertheless, this month, we're pulling out the tiny Arduino Nano 3.0 to create a simple 8-bit WAV digital audio player called 'nanoPlayer'.

HOW PWM WORKS

But if the Arduino Nano's 8-bit microchip doesn't have a built-in DAC, how can it play digital audio? The trick lies in the functionality the little ATMEGA328P chip possesses — a feature called 'pulse-width modulation' (PWM). It's a clever process that allows a digital output to simulate an analog voltage by switching its output high and low at high speed but changing the width of the positive-going digital pulse. If you vary or 'modulate' the pulse width or 'duty cycle' in proportion to the samples of an 8-bit digital audio file, the PWM output can give a decent averaged approximation of an analog voltage that represents those digital audio samples. Filter the output to reduce the PWM 'carrier' frequency, send it off to an audio amplifier and you'll hear the audio from that file.

VERSION 2.0

Like our digital audio recorder from last month, the nanoPlayer is really a 'version 2.0' of the digital audio player



we made a few years ago that featured an Arduino Uno and the Ethernet Shield. It was inspired by an earlier simple single-button digital audio player built from a Raspberry Pi. At the time, we thought the R-Pi for that task was a bit 'overkill', so we built an Arduino version to do the same thing. However, at the time, reliable SD card readers that could interface with the Arduino weren't as common and using the Ethernet Shield gave us the best results, but a large bulky design.

Today, we've completely redesigned it to use a tiny Arduino Nano 3.0 plus a low-cost microSD card reader module that has built-in voltage-level translation (VLT).

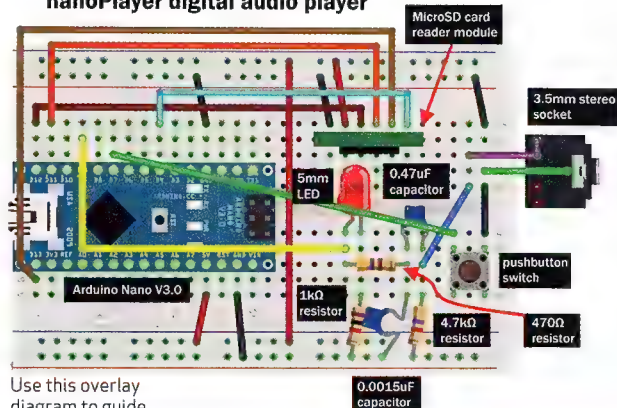
Why VLT? microSD cards run on 3.3 volts while the Arduino boards typically run on 5.0-volts. Sending 5 volts to a 3.3-volt microSD card isn't a crash-hot idea, so VLT ensures the voltage levels of the digital I/O are

translated correctly and everyone's happy.

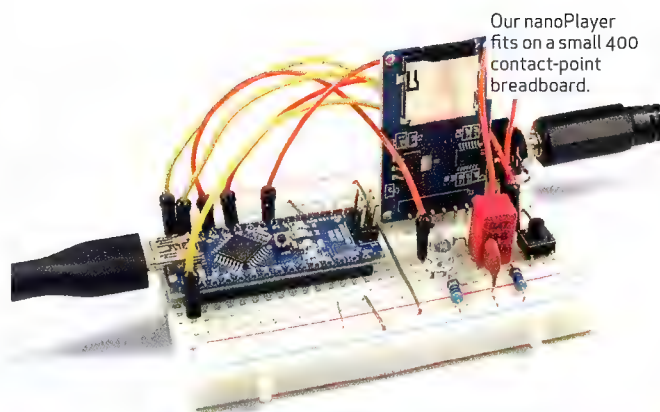
MINI BREADBOARD

The other difference this time around is the use of a mini 400-point breadboard. These things are absolutely brilliant and get my nod for inclusion in 'brilliant inventions of the 20th century'. The key with breadboards is that the contact points are grouped vertically in columns, broken into two halves by a gap right across the middle. The other detail is that all column points are on a 0.1-inch (2.54mm) pitch, matching DIP (dual-inline) chips. The first integrated circuits were developed in the US, the US uses inches and they settled on 0.1-inch pitch. Although bypassed for smaller-scale surface mount tech, 0.1-inch pitch still works a treat for homebrew design.

nanoPlayer digital audio player



Use this overlay diagram to guide your build.



Our nanoPlayer fits on a small 400 contact-point breadboard.

HOW THE PLAYER WORKS

First, you plug your microSD card into the reader module and power up the Arduino. If the Arduino finds a valid microSD card, it double-flashes the LED on pin D9 and is good to go. If not, you get never-ending slow flashes. Press the momentary-on pushbutton switch connected to pin D7 and the Arduino Nano searches for and locates the first file in the SD card's root folder.

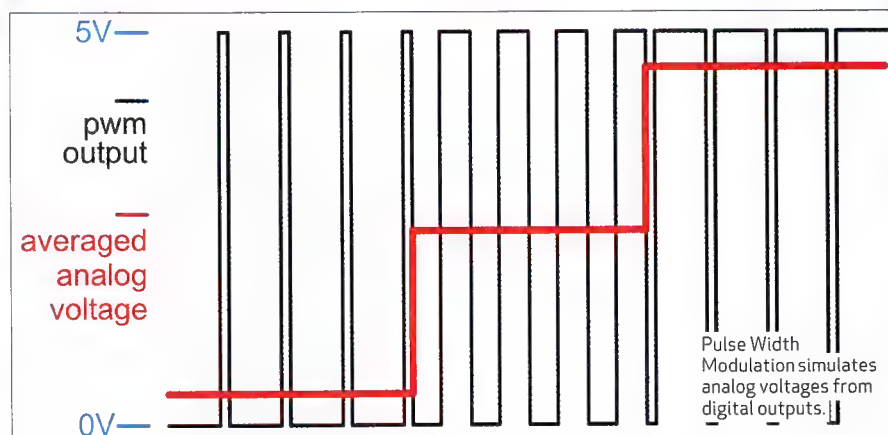
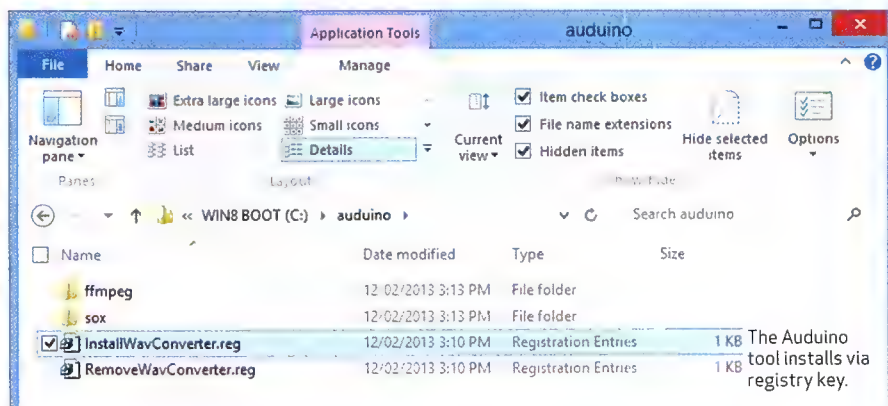
To turn that file into PWM output, we're using the clever TMRpcm library by [TMRh20]. It's fast enough to handle WAV files up to 19kHz sample-rate and 8-bit depth – not exactly 'Hi-Fi' but good enough for many applications.

Our code sets the library to begin decoding the WAV file and feeding it out as PWM output on pin D9. From here, the PWM signal lights up the LED to show you the output is working. It's then filtered by a 4.7kohm resistor and 0.0015uF capacitor, before being AC-coupled by a 0.47uF capacitor and 4.7kohm resistor to the 3.5mm output socket. Next, you plug in a 3.5mm cable to your audio amplifier or computer speakers, turn up the volume and out comes the audio.

During playback, the pushbutton switch becomes a toggle on/off pause button.

COMBINE WITH DIGITAL AUDIO RECORDER

Clearly 19kHz/8-bit WAV mono audio files aren't common, but we've got a couple of solutions for that. First, if you build the digital audio recorder, either last month's Arduino Mega version, or the original one on our website (tinyurl.com/zr5d9zr), and set the recording sample rate to '19,000', the files you record will play on the nanoPlayer. Second, if you head online to the original digital audio player project (tinyurl.com/j3nah9s), we created a very simple converter that takes any audio file and converts it into 19kHz/8-bit WAV format through a simple right-click context menu in Windows Explorer. Unzip the 'audino.zip' file and you'll find two registry keys –



'InstallWavConverter.reg' installs the converter into the registry and Windows Explorer, 'RemoveWavConverter.reg' removes it. Make sure you copy the contents of the zip file to 'c:\audino' on your Windows computer or it won't work. Or, you can convert files manually through Audacity.

GETTING THE PARTS

Use the overlay diagram as your build guide and you shouldn't go too far wrong. The Arduino Nano 3.0 board and the microSD card module were purchased from eBay. Everything else, you can get from Jaycar Electronics or Altronics.

GETTING THE CODE

You'll find the source code for the project on our website (apcmag.com/

magstuff). Unzip the file, then copy the contents of the /libraries folder to the same of your Arduino IDE (we used version 1.6.5). Restart the IDE, load up the nanoplayer.ino file, build the project, flash the code to the Arduino nano and you should be away.

CAN IT BE IMPROVED?

The original purpose for the nanoPlayer was for a prototype single-button audio player that was easy to use and could play music or audiobooks. We've used the TMRpcm library here as a quick example, but given we've created a digital audio recorder that can record up to 48kHz sample-rate, we're hopeful of improving on the 19kHz WAV file support provided here over the coming months. ■

Write your own client/server apps

This month, Darren Yates begins looking at network coding in Java with an introduction to writing your own client and server applications.

Throughout this Learn to Code series, we've been slowly cranking up the complexity of the Java code we've created, looking at concepts from assigning values to variables, right through to how to create multi-threaded apps. But in everything we've done so far, we've only been running code on just the one computer.

This month, we're taking our first simple steps into Java networking and learning how to send and receive data between two computers. The end goal will be to create a multi-user chat system, coding both the server and client sides and running it on your local network.

TCP/IP BASICS

Networking in general can scare the daylight out of even seasoned professionals, but just understanding the basics can really help you in your coding. All networking is about sending and receiving data between locations in such a way that the data arrives as quickly as possible (routing) and reliably handles transmission failure (error recovery).

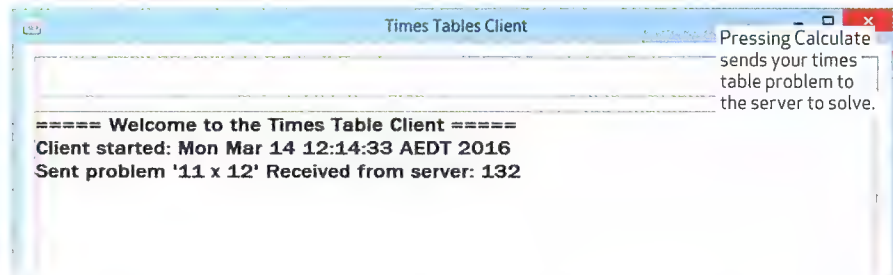
Put simply, data transmission typically involves four network layers.

Application layer — this is the layer where HyperText Transfer Protocol (HTTP), File Transfer Protocol (FTP) and other protocols are often used. It's essentially your app's data level.

Transport layer — this layer encapsulates your data with a Transmission Control Protocol (TCP) transport header, adding connection continuity, error recovery and flow control parameters.

Network layer — this layer further encapsulates the data and TCP header with an Internet Protocol (IP) header providing addressing or 'routing' parameters.

Network Access or Link layer — at this layer, the data is encapsulated yet again, this time with communications protocols, depending on the relative location. For local routing, a MAC (Medium Access Control) header is added. If sending the data across the Internet, the MAC header is replaced by Wide Area Network (WAN) header.



```
private void jBtnCalculateActionPerformed(java.awt.event.ActionEvent e) {
    try {
        dataOut.writeUTF(jTextProblem.getText().trim());
        dataOut.flush();
        String answerFromServer = dataIn.readUTF();
        jTextFromServer.append("Sent problem '" + jTextProblem.getText().trim() + "' + "
            + "Received from server: " + answerFromServer + "\n");
        jTextProblem.setText("");
    } catch (IOException ex) {
        Logger.getLogger(ClientFrame.class.getName()).log(Level.SEVERE, null, ex);
    }
}
```

```
try {
    Socket client = new Socket("localhost", 3801);
    dataIn = new DataInputStream(client.getInputStream());
    dataOut = new DataOutputStream(client.getOutputStream());
} catch (IOException ex) {
    Logger.getLogger(ClientFrame.class.getName()).log(Level.SEVERE, null, ex);
}
```

The fully encapsulated data packet then hits the cables in what's called the 'physical layer', converted into electrical voltages as it whizzes around your network or around the world.

Together, these layers form the Internet Protocol Suite, and if you combine the transport and network layers, you get the TCP/IP protocol pairing that makes the Internet work.

At the destination end, the router pulls off the WAN header and replaces it with the appropriate MAC header for that local area network. The data block or 'packet' is then progressively stripped of each header encapsulation as it goes back up the layers at the destination end, until the last thing remaining by the time it reaches the application layer is just the original data.

Now, there are big thick books written about TCP/IP, so I'm on a hiding-to-nothing trying to cover it in a couple of paragraphs. But just be

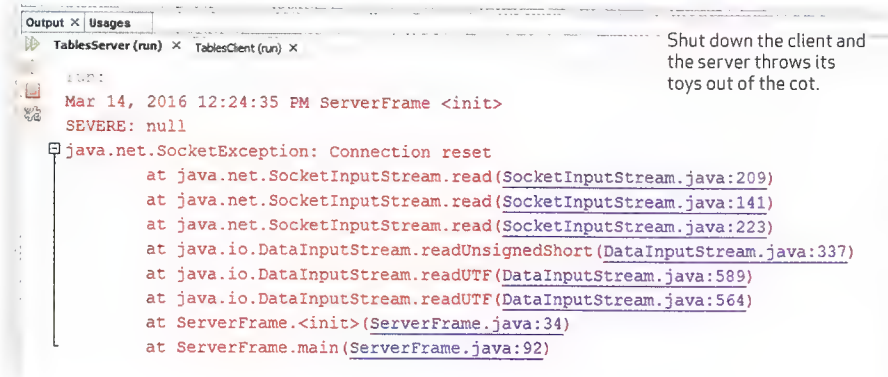
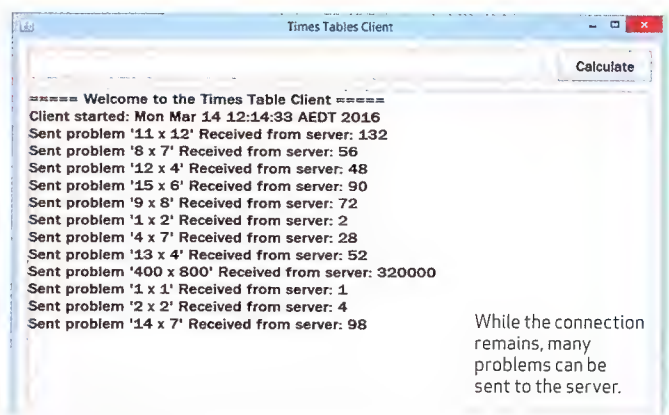
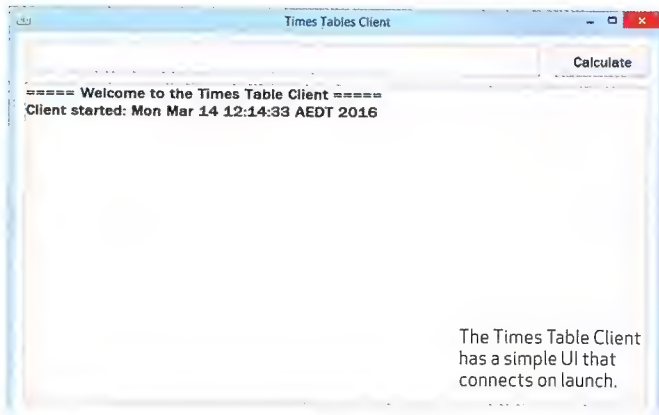
aware it's a series of network communication layers that controls how data is reliably transmitted.

JAVA NETWORKING

Thankfully, that's about as much theory as you need to start playing around with Java network coding.

In simple terms, transferring data over a network relies on two computers negotiating roles between them — one acting as a 'server', the other as 'client'. Now, we throw these terms around like lollies, but it's important to understand them and what they actually represent. A client is a computer that makes a request for data from a server and the server's role is to be ever ready to supply the data requested.

The process begins with the server awaiting a data request from a client on the network. The client then requests a connection to the server and the server says yes or no. If 'no', the client should ideally wait for a time period and try again. If it's 'yes', the two



connect, the client makes its data request and, if the server has the data, sends it back to the client.

A client can only make one server connection at a time, whereas a server can typically handle many clients at once. However, the key is that the connection between a client and server in Java occurs through 'sockets'. Java has two socket classes – 'ServerSocket' for creating a server and 'Socket' for creating a client.

SERVER LISTENS

Every time we've created a JButton in an app so far, we've attached a Listener object to it that continually monitors for when that button is pressed. Servers are similar, but in a more complex way. A server is normally seen as a heavy-duty computer with buckets of storage, but at a software level, it's just an app continually listening out for connection requests from clients. That means the server application needs to be running first, otherwise the clients will just be whistling in the wind.

Yet, just as there's not much point waiting for a phone call if no-one knows your phone number, the same goes for running a server. So when creating a server app, we have to create a phone number, which consists of the server computer's network connection (IP address) and a TCP 'port' number.

Just briefly, the IP address is the common 32-bit dotted address you're no doubt familiar with, for example 192.168.0.1, while the TCP port address

is a 16-bit number between 1025 and 65535. A TCP data packet is encoded with source and destination port numbers, but in both cases, the bottom 1024 port numbers are usually reserved.

So putting this altogether in Java, we can create a simple server with just the single line:

```
ServerSocket server = new
ServerSocket(3801);
```

The IP address is set by the computer's network connection, but the port number you can choose from the above range, and here, we've chosen '3801'. But to now set that server to begin listening for a client connection request, we need to activate it and we do that with:

```
Socket socket = server.
accept();
```

We create a Socket class object called 'socket', but what's unusual about this code line is that, once Java sees it, it doesn't proceed beyond this point until it receives that connection request, so it's a bit like a 'wait' or 'delay' statement.

INPUT/OUTPUT STREAMING

With the server initialised and waiting, what happens when it receives a connection request? Thankfully, Java, your OS and your networking gear handle all the really tough stuff, but we still need to create two data

connections – one coming into the server, the other going out back to the client, both through the connecting socket. The way Java does this is very similar to handling file I/O – by data streams. 'DataInputStream' is the stream class used to accept data from the client and 'DataOutputStream' does the job going back the other way. We create the two stream objects with:

```
DataInputStream dataIn = new
DataInputStream(socket.
getInputStream());
DataOutputStream dataOut =
new DataOutputStream(socket.
getOutputStream());
```

From here, we read the input from the client through 'dataIn' and write data back out to the client through 'dataOut'.

CLIENTS TALK

Okay, the server is up and running, now we turn our attention to the client. Thankfully, they're quite similar. We start by creating a Socket object with the parameters that are essentially the phone number of the server we want to dial up. We do that with:

```
Socket client = new
Socket("localhost", 3801);
```

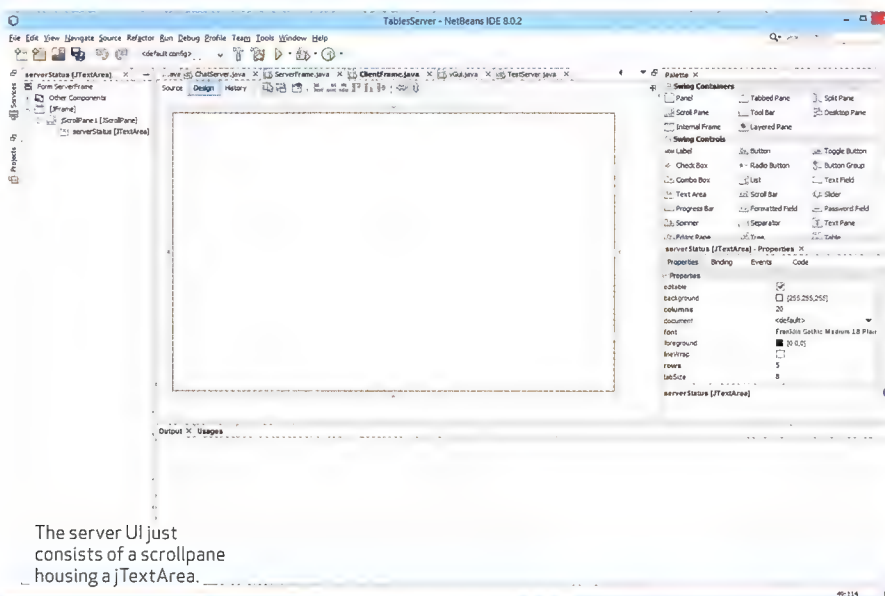
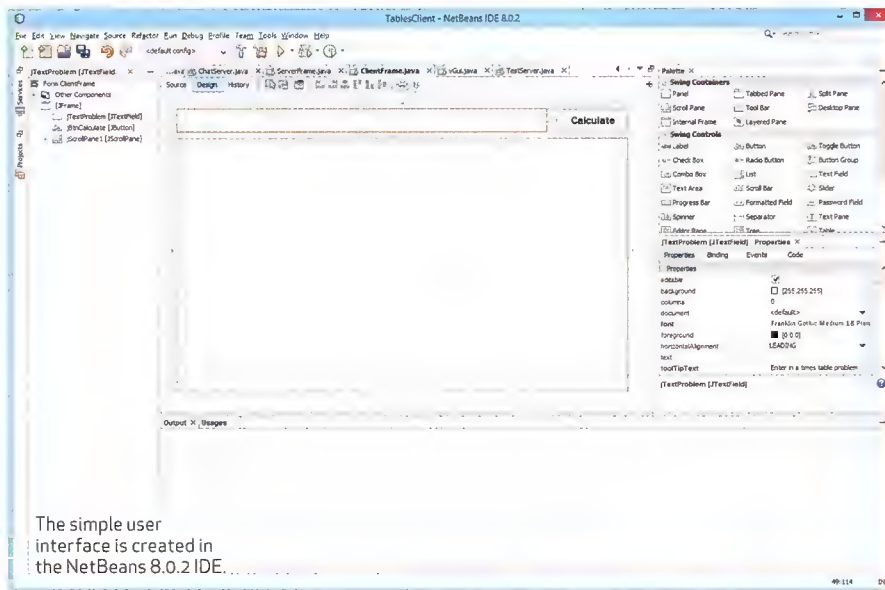
The parameter "localhost" is cheat-code for when you're running the client and the server on the same box. If the server is on another computer, you replace 'localhost' with the IP address, such as:

```
Socket client = new
Socket("192.168.0.4", 3801);
```

Again, we use the DataInputStream and DataOutputStream classes to create objects that talk to the server.

MAKING YOUR FIRST SERVER

So let's try all this out and see how it works in practice. Grab the 'apc_clientserver.zip' source code from the APC website (apcmag.com/magstuff), unzip it, open up NetBeans, import the inner 'TablesServer.zip' project file



(File, Import Project, From Zip) and run it. Next, import the 'TablesClient.zip' project file and run that.

This simple client/server project allows the client app to send a times tables maths question to the server app, something like '8 x 7'. The server accepts input from the client, calculates the problem result and sends it back to the client. It's scintillating stuff, for sure, but it shows the basic techniques required for getting two apps talking to each other – and that's still pretty cool!

TABLESSERVER PROJECT

Let's start with the server side code, since we need this running first. The user interface consists of a single JTextArea inside a JScrollPane – that enables the vertical scroll bars when text flows beyond the visible JFrame window area. And that's it.

The actual server code itself is as simple as you can get and sits inside the 'try' statement block. It begins with initialising the 'serverStatus' text area with time, date and server IP address, followed by setting up the ServerSocket with its port (3801) and starting the socket using statements we looked at previously.

The code waits until it receives a connection request from a client, at which point, we initialise the input and output stream objects, so the server can read and write data to the connecting client.

With the sockets and input and output streams now set up, we run the server inside an infinite while() loop. It starts with initialising the string called 'problem' that waits for input on the input stream, reading it as a UTF string of characters. We then split that string (which should be something like '7 x 6') into separate integers using the String.split() function, splitting on the 'x' character and storing the arguments in two integer variables, arg1 and arg2. Next, we send the multiplication result of those two arguments back out to the client over the data output stream and make a log note in the serverStatus text area.

Following that, the while(true) loop kicks over, the code sits at the dataIn.readUTF() statement again, waiting for more input from the client.

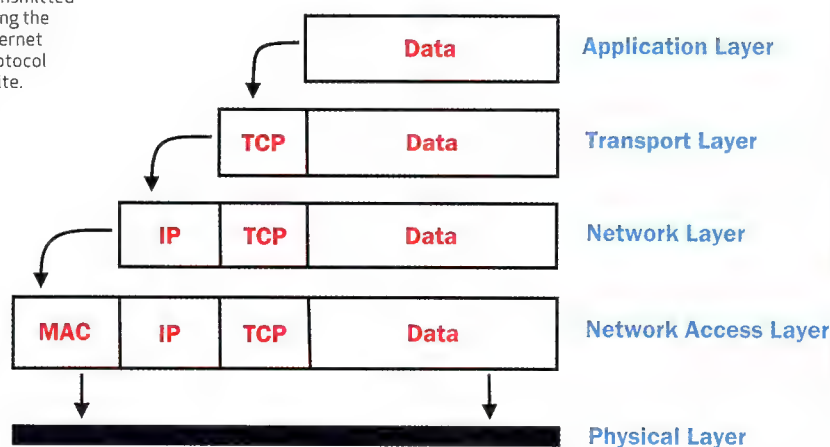
TABLESCIENT PROJECT

Since the server's job is to respond to client requests, we design the client to make those requests. The user interface is only slightly more complex, with a JTextField for entering in the times table problem, a JButton to initiate sending of the problem to the server and a JTextArea to display both the times table problem and answer from the server.

Again, the initialisation code bits are inside the try{} statement block,

Network data is commonly transmitted using the Internet Protocol Suite.

Simplified data packet transmission




```
try {
    serverStatus.append("== Welcome to the Times Table Server ==\n");
    serverStatus.append("Server started: " + new Date());
    serverStatus.append(" Server IP Address: " + InetAddress.getLocalHost()+"\n");
    server = new ServerSocket(3801);
    Socket socket = server.accept();
    DataInputStream dataIn = new DataInputStream(socket.getInputStream());
    DataOutputStream dataOut = new DataOutputStream(socket.getOutputStream());
    while (true) {
        String problem = dataIn.readUTF();
        System.out.println(problem);
        String[] args = problem.split("x");
        int arg1 = Integer.parseInt(args[0].trim());
        int arg2 = Integer.parseInt(args[1].trim());
        dataOut.writeUTF((arg1*arg2)+"");
        serverStatus.append(new Date()+" Received request: "+arg1+"x"+arg2+" Sent back: "+(arg1*arg2)+"\n\n");
    }
}
```

The whole Times Table Server code in a few lines.

starting with a connection request to the 'localhost' IP address as port '3801', where our server is expected to be ready and waiting. We then create a pair of data input and output stream objects as before – and that's it.

However, the important part of the code occurs inside the 'jBtnCalculateActionPerformed' private method. This is basically just an ActionListener for the Calculate button, and as soon as it's pressed, this method fires up. First, we send the trimmed text that is our times table problem inside the 'jTextProblem' jTextField to the server via the dataOut data output stream object. After that, we clear or 'flush' the stream object and wait for the return data from the server through the dataIn input stream object.

Once that data (the answer to the multiplication problem) arrives, we append it to the jTextFromServer jTextArea. And we're done.

THE PROBLEM(S)

Now as simple as this client/server example is, it does have a couple of major flaws – the first is that the server can only accept one client connection and, as soon as that connection is broken, that's it – game over. The only way to get the system back up and running is to reboot the server and client apps. But while the connection remains open, you can send as many times table problems to the server as you like – close that connection and the server is done.

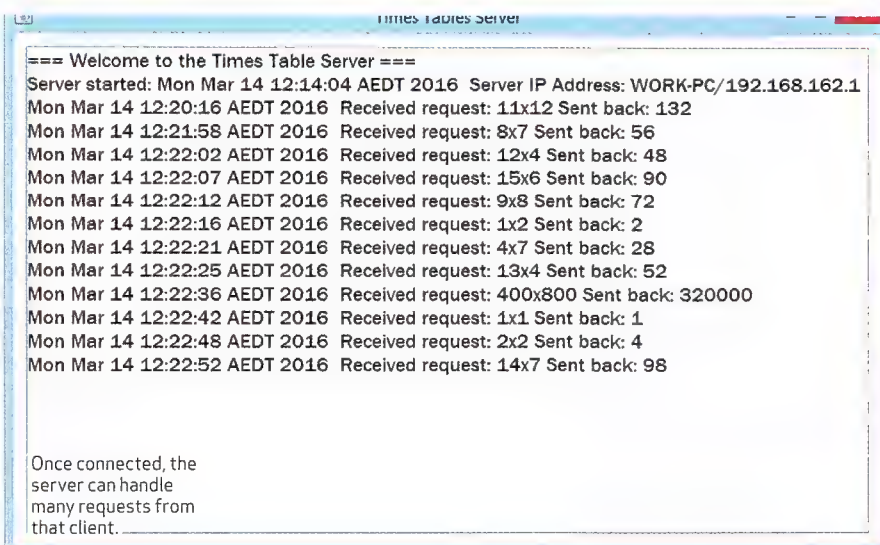
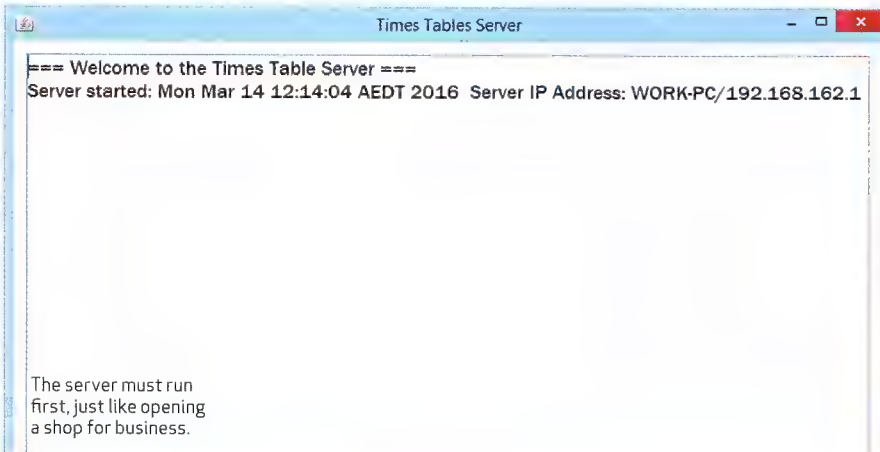
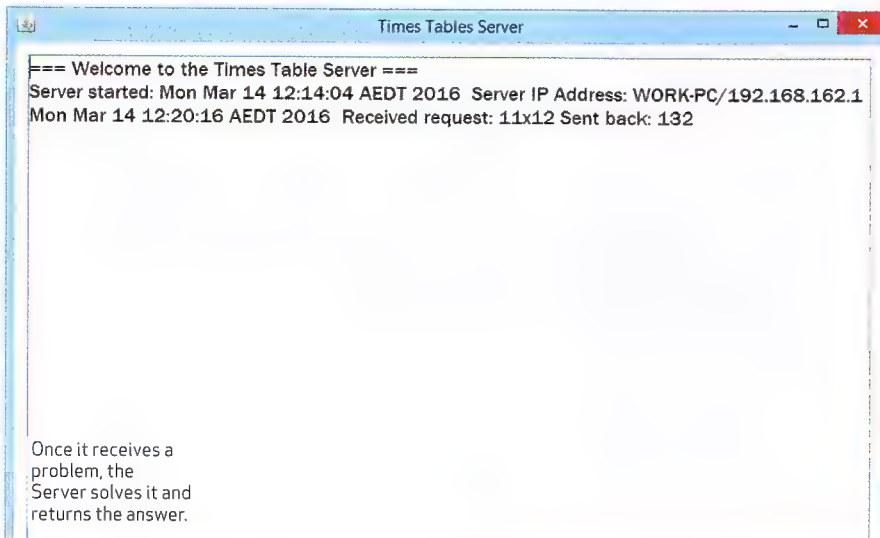
What's the solution? Threads! We've been banging on for a few months now about how important threads are to proper coding, and if you plan to code a server capable of supporting multiple client connections, you're going to need to implement threads.

The second flaw, entirely of our own making, is there's absolutely no error recovery in either app whatsoever – that means, if the client shuts down for some reason, the server spits the dummy and sulks in the corner.

But that's a comparatively easy fix. What's more important for now is making sure you see how client and server apps work, how you set up the communications channels between them and how they actually communicate. And hopefully, you've seen from this simple example that it's not really rocket surgery.

NEXT TIME...

Now that we've got the basics under our belts, we're ready to ratchet things up another notch and, next time, build our multi-threaded local chat system that supports multiple clients broadcasting messages globally and gracefully handles lost connections. The whole thing works a little like your own Twitter system. Join us then. ■





FROM \$89.95 | PC, PS4, X1 | WWW.TOMCLANCY-THEDIVISION.UBI.COM

Tom Clancy's The Division

Cover shooting and RPG progression don't quite fit together.

I'm cornered by three strangers. They can see the loot I'm carrying on my back. I expect them to shoot any second – instead, all three start doing jumping jacks in unison. Welcome to *The Division*, where fitness comes first. I joined in and they helped me extract my loot from the PvP Dark Zone. We spent the next hour parading through central Manhattan, helping out strangers in need and hunting down rogue soldiers in a series of vigilante revenge quests.

The Division is an open-world RPG co-op cover shooter set in the ruins of Manhattan after a bout of bioterrorism on Black Friday sent the city spiralling into a mini-apocalypse. Manhattan is quarantined, so the Division, a covert federal force, is sent into the city to restore some semblance of federal civility, by shooting everyone highlighted in red.

TAKE COVER

The Division is a collection of story missions, side missions, and random combat encounters. You can opt to tackle them alone, with three friends, or with strangers via matchmaking. Safe houses

are small social hubs and the only place you'll meet other players outside of your team (besides the Dark Zone).

Fighting the AI can be tense and challenging, especially when you have teammates. Press a key to take cover on corners or highlighted chest-high objects. From cover, you can blindfire, take aim, toss grenades or use one of your class abilities, such as throwing out an automated turret that suppresses nearby enemies or a med station that heals everyone in a radius. I rarely had time to dig in, as enemies flanked or sent explosives my direction with reckless abandon. Under that kind of pressure, I changed cover a lot, and with ease. Highlight the cover you want to move to with the camera and hold a key to go there. That simple movement meant I didn't have to manoeuvre around a tangle of obstacles, creating space for more improvisational thinking.

During intense firefights, conversations with teammates fell into a natural rhythm based on abilities and weapons equipped. I ran with a semi-automatic shotgun, a cover-reinforcing buff and a

turret. In my favourite scenario, two tanky shielded enemies paired with a medic walked up a tight corridor toward our cover. I threw out my turret to distract the shielded enemies, my teammates told me they'd suppress, and I took off to the other end of the corridor to get behind their line of defence, take out the medic, and open up the shielded enemies to fire.

The Division punishes bad decisions well enough (stay out of cover too long, get shot; stay in one place too long, get flanked), so it's disappointing that the elite enemies are just prolonged versions of regular encounters and that they're used so often. Elites don't employ especially erratic behaviour, or complex patterns: they just swallow magazine after magazine while talking smack.

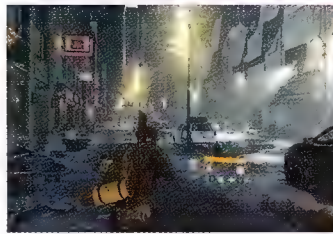
When my teammates and I were around the same level, and played missions at or just below the recommended starting point, the combat was usually a good challenge. We depended on one another to fill out blind spots: I was a shotgunner, so we knew a sniper would be necessary. If I had the turret and cover buff equipped for flanking, a

teammate would spec out a medic class on the fly.

However, incentive to play with one another faded as our levels grew apart. All it took was one teammate a few levels higher to turn balanced combat into a personal shooting gallery. Conversely, when matchmaking for some of the later missions, I was often thrown into a team of antsy players who were one-hit-and-dead underleveled.

There's no way to just power through the campaign, where the best level design and encounters are, as they don't reward enough XP to prep you for the next. Collectibles and killing enemies give out even less XP, which leaves the side missions as the primary gate between you and the best parts of *The Division*.

Some side missions feed reward points that feed into upgrading your base of operations, a repurposed post office full of repetitive NPCs and visual rewards that coincide with newly unlocked perks, combat abilities and passive abilities. Most boil down to defending a point from enemy waves or infiltrating a warehouse to kill an elite enemy. They only take five to ten minutes to complete, but it does mean dedicating hours to them to fully upgrade perks and abilities.



Thankfully, Manhattan is gorgeous. With settings maxed, minute details stand out. Glass, tile and fabrics shatter and perforate almost like their real-life counterparts. Hazy golden-hour light spills into the slick city streets, while thick snowstorms turn streetlamps into conical havens and wandering NPCs into creepy silhouettes. Post-processing and weather effects layer on a grimy, sterile palette. Areas are stocked with natural props (one with giant Christmas ornaments), and most can be shot, which make otherwise routine firefights cloudy and frenetic with debris.

The overarching story is poorly communicated and easily ignored. It's a political narrative nested in a game about simple, material rewards, where you're saving a city by killing half the people in it. In *The Division's* most discordant moment, a friend and I walked through a scene in the campaign where dozens of coffins and bodies, some covered in American flags, littered the sewers. When I climbed down for a closer look, it wasn't to see what I could learn about what happened here, but to see if a loot chest was nestled between the coffins. By the story's conclusion, hardly anything is resolved; it's left set up for as many small narratives as *The Division* needs for future expansions.

But there's nothing lost by missing the pulpy sociopolitical beats — it's nice enough as a wash of moody light and sound.

THE DARKNESS

At the literal core of the game is the Dark Zone, by far its most interesting element. It's a social exercise in stranger danger: a huge section of the map dotted with elite enemy mobs, hidden chests and other players. The catch is that loot is contaminated and can only be extracted via helicopter. Every time this happens, all the players in the DZ are alerted to the drop's exact location. They can help stave off the waves of incoming enemies, or kill you and take your stuff. Doing so marks them as rogue, and 'pure' players get a reward for taking them down. Sometimes, nothing would happen for an hour and I'd extract loot as a lone wolf without issue. Sometimes, we'd befriend other players and roam the map like some preternatural loot-extraction force. Sometimes, a group would remember my name and hunt me down repeatedly. That's what I get for name-calling. It's unpredictable, tense and my favourite way to upgrade weapons and gear. But even in the Dark Zone, the drip slowed soon enough, and I was confronted with what exactly to do with my hoard of high-level stuff. Not much.

The endgame is vapid. Daily missions unlock at level 30, but they're just campaign levels with difficulty modifiers that reward crafting material, which I've yet to find useful. There's more powerful loot to find, but it all requires serious amounts of repetition to obtain. And afterwards, there's nothing except the same levels and enemies to test it out on. Free updates are on the way with Incursions, scenarios designed to test players in the endgame, but until they're out, the sense of progression is distilled into fleeting number comparisons between weapons that feel pretty much the same to shoot.

The RPG-ness of *The Division* is no more sacred than *Diablo III's*. Numbers spill out, you collect resources, loot and make the numbers spill out faster. Beneath all the excess is a challenging and strategic co-op cover shooter that deserves an audience; however, *The Division* hasn't quite been able to get the kill/reward ratio quite right and as it stands, there's an arduous grind to look forward to if you happen to make it that far.

■ James Davenport

Verdict

A challenging co-op cover shooter and a gorgeous open world diminished by unnecessary RPG tropes.



SwapQuest

My kingdom for a tile puzzle.

US\$6.99 | PSVITA
SWAPQUEST.DE

Remember the hacking mini-game from *Bioshock*? You know, the one in which you need to arrange a path by swapping maze pieces and creating a line from one side to another. Well, this PS Vita title takes that concept, stretches it to near breaking point and uses it to build a charming curio. Kicking off with a generic medieval kingdom in danger, there are plenty of old-school RPG tropes that add some extra flavour to the puzzles. Pick between Wilbert or Wilma, choose their class, and go off to save the world. Well, solve some scrolling puzzles actually. Throughout the levels, you need to swap tiles to make a trail for your character to walk down, and dotted across them are chests full of jewels, enemies to battle and shards of a crystal ball you need to discover for the standard story. Relatively simple to begin with, the challenge comes from keeping ahead of The Horde — a demonic cloud at the bottom of the screen — which is constantly on your tail. Satisfyingly demanding for both fingers and brains, *SwapQuest* also excels at bending its concept to keep every level fresh. One moment, you might be wandering a desert, needing to find water sources to ensure you don't die from dehydration. The next, you're stumbling through a foggy swamp, only able to see immediately ahead of you. The variety in design is certainly impressive. Intriguing and brief, this cheerful indie head-scratcher is pleasant while it lasts. ■ Ben Tyrer



"Giant mounted guns spit a whirl of projectiles and handle like firehoses, severing alien legs at the knees."

US\$29.99 | PC | WWW.GEARSOFWAR.COM

Gears of War: Ultimate Edition

A disappointing PC version of a great game.

My criticisms of *Gears of War* haven't changed much, which is exceptional for an Xbox 360 game from 2006. Long after it first redesigned third-person shooting into a chunky, cover-to-cover alien meatgrinder, *Gears* is still fun as hell and doesn't feel dated. It's aged wonderfully, tasting just a bit better even, because it sticks out among modern shooters as thicker, stronger and simpler.

But it's grown some pretty gross mould, too. This new *Ultimate Edition* is one of those fancy DirectX 12 games built as a Universal Windows App, which is supposed to make it more efficient and simpler on us but, in this case, has only introduced limitations. It looks great — the stones are grimmer, the meatheads gruffer — but do you want to play at an ultrawide resolution? There's no ini to edit. Want to record a session

with ShadowPlay? You can't, so get used to Xbox DVR (which sucks). And you'd better hope *Gears* likes your videocard, because it doesn't like my GTX Titan or the GTX 980 Ti we tried it on in the office, and that grudge comes as nasty audio and video stuttering if I have the texture quality above 'low'. Microsoft is working on it, but it's still a pain a week after launch.

Gears softens the frustration by being so much fun. The campaign can be a little self-serious — it's *Doom* as an ensemble action flick like *The Expendables*, with a cast of ultimate tough guys flexing their neck-trunks at every problem — but there's no drawn-out character development or weak attempts at high-concept sci-fi. Yeah, the cast is a bunch of melancholy soldier archetypes, and the grimdark gothic stonework becomes a grey paste in places. But I only have to care about that for one minute of

walk and talk exposition, and then I get to spend 20 minutes with *Gears*'s wonderful shooting in a shower of alien gore.

Gears still owns one of the best cover systems ever. The spacebar puts in a lot of work: hold it to charge forward, tap it to enter cover, and hit it with a direction key to move between cover points, dive into the open or hurdle over a concrete barrier. The battlefields are like strategy game boards, with cover points arranged at 90 degree angles to each other. The guns are fierce, imprecise fun. You can spray tracer bullets wildly over cover or more neatly down the sights. Giant mounted guns spit a whirl of projectiles and handle like firehoses, severing alien legs at the knees. Shotguns are hole-punches for headcrab-like rug beasts. There's even an orbital beam weapon, guided by a targeting gun.

Gears is at its best in co-op, and on that front, I managed

to find a random player to join up with for some brief shooty friendship. The competitive multiplayer is quieter, and that's part of the reason I won't be recommending *Ultimate Edition* wholeheartedly. *Gears* has some pretty fun multiplayer, but it can take a while to get into a match. And despite how good *Gears* still is, the stuttering issue is a big pain, and even if Microsoft fixes it, this will still be a limited piece of software.

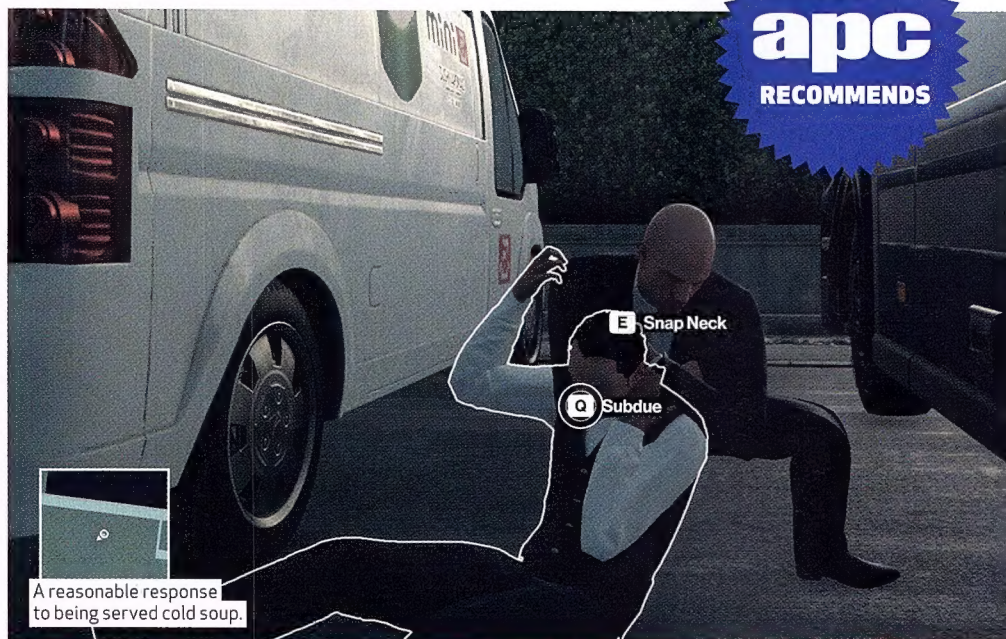
You can't inject shaders, or capture video with the tool you like, or do anything we've become accustomed to doing on our wonderfully open platform. *Gears of War* is a great game, but the spirit of PC gaming does not inhabit this muscley incubus.

■ Tyler Wilde

Verdict

Gears of War is as fun as ever, but the technical flaws and limitations of *Ultimate Edition* are disappointing.





✓✓✓
apc
RECOMMENDS

FROM US\$14.99 | PC, PS4, X1 | WWW.HITMAN.COM

Hitman: Intro Pack

A strong first level, but struggles with its execution.

In many ways, this latest *Hitman* is exactly what I – someone who loved *Blood Money* and disliked *Absolution* – wanted the series to do next. This first episode, available as a standalone Intro Pack, contains a couple of smaller tutorial levels and one full-size mission. That might not sound like much, but the Showstopper level, set in a Parisian palace, is a huge, intricate sandbox filled with possibilities for you to explore.

Hitman takes *Absolution*'s accessibility – a slick third-person control scheme, and 'Instinct' mode, which highlights targets, weapons and other key information – and applies it to *Blood Money*'s broad sandbox design. There are snippets of story, but they're seeded into incidental conversations and cutscenes that take place after each mission.

As Agent 47, you're free to take down your targets in any way you please. As in *Blood Money*, part of the joy is that you're given the space to stop and observe. 47 has an invite to the fashion show his targets are running, and that means you've got limited access from the start.

To venture deeper into the palace, however, you'll need to acquire a disguise.

Disguises, and the suspicion 47 raises while wearing them, are something the *Hitman* series previously struggled with. Here, it's more transparent, and feels more consistent than ever before.

Getting close to a target is just half the challenge. The act of killing is just as open to experimentation. *Hitman* supports a variety of playstyles, from clean, professional hit to destructive murder spree. I've spent nearly 15 hours in *Hitman*, much of it in Paris, and I'm still finding new ways to dispatch Viktor and Dalia. They've been shot, stabbed, poisoned, drowned and bludgeoned. I think I'll try explosions next.

If you need a little direction, a new Opportunities system guides you towards some unique solutions. It works like an expanded version of *Blood Money*'s setpiece accidents, and points you at some of Paris's most satisfying kills. However, by far the biggest annoyance is that, if you lose your Internet connection while playing, you're kicked

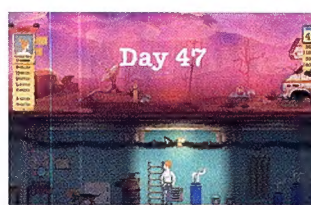
out of the mission and back to the main menu. *Hitman* doesn't have always-on DRM – an offline mode is available – but challenges, and the post-mission unlocks that you receive for completing them, are all tied to online mode. Worse, the game uses different saves for offline and online, so if you can't reconnect, you won't be able to reload your existing run.

I'd be less bothered if the online functionality justified such extreme measures. But the returning user-created Contracts mode is barebones, with limited options for scenario creation and no ability to search through or filter published missions.

It's one thing that *Hitman* is episodic but the lack of polish makes this initial release feel like a beta. Right now, it's a great game but a poor user experience. While this Intro Pack shows a lot of promise, it falls short of a recommendation. ■ Phil Savage

Verdict

Despite being a smart progression of *Blood Money*'s ideas, *Hitman* feels unrefined and unfinished in many ways.



Sheltered

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Think your item-hoarding days died with the ink ribbon? Think again. On day one of shelterdom, you might be content with a few petrol cans, but by day 47, you'll be squirrelling away mannequin heads as if they're megalixirs. A post-apocalyptic survival game in which family comes first, *Sheltered* slots into the not-so-snug gap between *Fallout Shelter* and *The Sims*. Set in a world in which anti-radiation tablets are as common as candy canes at Christmas, you need to micromanage your nuclear family in their daily grind for no better reason than that old arcade chestnut: the high score. Like *The Sims*, your family members have bars that indicate when they need to perform basic functions such as showering and snoozing. Unlike *The Sims*, however, goopy carbonara isn't on the menu. Instead, there are tinned rations. *Sheltered*'s bunker provides a high-maintenance alternative to *Fallout Shelter*'s vault, but it's not just a never-ending story of repair jobs. To furnish your whitewashed wonderland, you have to craft objects using teddy bears, duct tape and, you guessed it, junk. Can't contain your excitement? Express it on the walls using a discarded can of paint or, better yet, organise a family outing to gather supplies and recruit new members in the pixelated wastes. If you've ever wished *The Sims* had grittier expansion options than *Katy Perry's Sweet Treats*, this could be a dream come true. ■ Jenny Baker



Birds of a feather scan together

Backpack-wearing pigeons report back London's air quality.

Pigeon Air Patrol, a squadron of ten trained racing pigeons, has been monitoring the skies across London recently. You'll be forgiven for thinking this is the next family-friendly movie from Aardman Animations. Each bird has been fitted with its own utility jacket, on which is connected a small air-quality sensor in an attempt to gauge the levels of nitrogen dioxide, ozone and other volatile compounds across the city. You can tweet your location to the Pigeon Air Patrol and receive a pollution rating in reply, or use the website. The folks over at Plume Labs, in partnership with the Imperial College London, are also asking for volunteers to test a wearable version of their monitoring device to get an on-the-ground reading.



Artificial story

AI-WRITTEN NOVEL PASSES FIRST ROUND OF JAPANESE LITERARY CONTEST.

While many people imagine the rise of the machines to be something along the lines of *Terminator* or *2001*, the reality of the development of AI may be quite different. *The Day a Computer Writes a Novel* is a "well-structured" short novel co-written by a Japanese AI program. This novel passed through the first round of the Nikkei Hoshi Sinichi Literary Award, a competition that has been open to AI submissions for the past few years; however, this is the first year any entries have been put forward. The team behind the AI, based out of Future University Hakodate, designed the program using segments or entire sentences, plus structural rules, then let the AI loose. As well as it performed, it didn't win, so we can all relax... for now.



Planet Licker is a game you literally play with your tongue

SLURP YOUR WAY TO THE STARS.

The Game Developers Conference is the largest "professionals-only" gaming event in the world, a place where ideas are showcased and discussed... and where precious saliva is spilt. *Planet Licker* has the gamer lick the controller, propelling a "friendly monster through a solar system of flavor". Each food-safe controller is equipped with three tasty icy popsicles, which the player strategically licks to move the character on the screen from planet to planet, avoiding obstacles such as mines. It's an interesting concept — sucking on a beet-flavoured popsicle to traverse the universe. Well, you can't say it isn't original anyway.

The pros and cons of crowdsourcing

CON: EVERYONE ACTS LIKE A 14-YEAR-OLD WHEN THEY'RE ONLINE.

Endeavour, Bounty, Victory, Indefatigable, Enterprise... all perfectly good names for ships. But if you ask the internet, they'll tell you that Boaty McBoatface is the best, and by a long way. The UK's National Environment Research Council (NERC) is an environmental science organisation that is currently building a new £200 million (~AUS\$376M) Antarctic survey ship/floating research lab, capable of chugging halfway around the world without stopping. Instead of sitting round a table and picking a name, however, NERC thought to put it to the public vote. As of the beginning of April, RSS Boaty McBoatface had gained over 112,000 votes, followed by RSS Poppy-Mai (22,800), RSS Henry Worsley (12,300) and my personal favourite RSS David Attenborough (9,100). ■



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